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# **AERONAUTICAL ENGINEERING**

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**A SPECIAL BIBLIOGRAPHY  
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Supplement 72**

**JULY 1976**

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

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**IAA (A-10000 Series)      A 76-25758 - A 76-28777**

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# AERONAUTICAL ENGINEERING

## A Special Bibliography

### Supplement 72

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in June 1976 in

- *Scientific and Technical Aerospace Reports (STAR)*
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

JULY 1976  
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# INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 184 reports, journal articles, and other documents originally announced in June 1976 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes—subject, personal author, and contract number—are included.

An annual cumulative index will be published.

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc (AIAA) as follows. Paper copies are available at \$5 00 per document up to a maximum of 20 pages. The charge for each additional page is 25 cents. Microfiche<sup>(1)</sup> are available at the rate of \$1 50 per microfiche for documents identified by the # symbol following the accession number. A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library. Minimum airmail postage to foreign countries is \$1 00. Please refer to the accession number, e.g., (A76-10091), when requesting publications.

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## **GENERAL AVAILABILITY**

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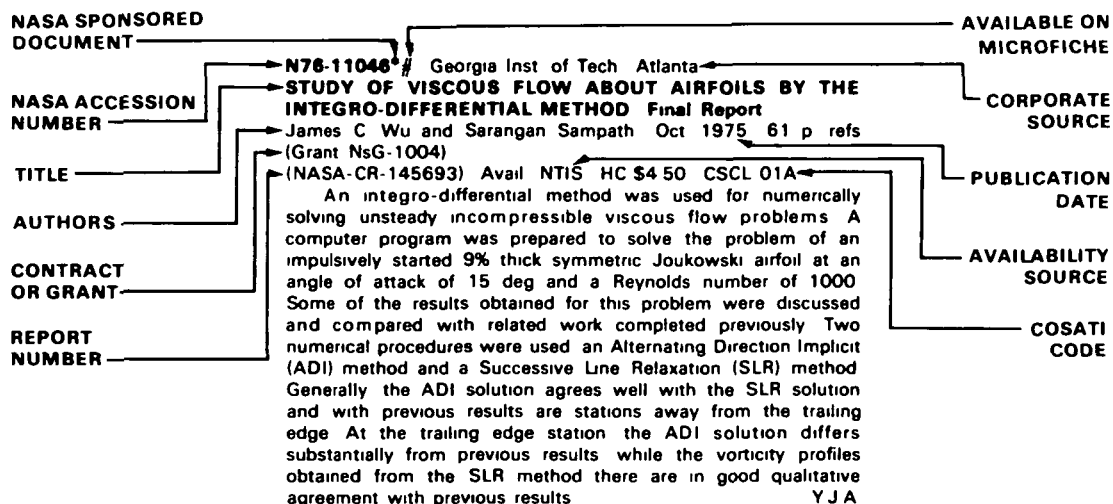
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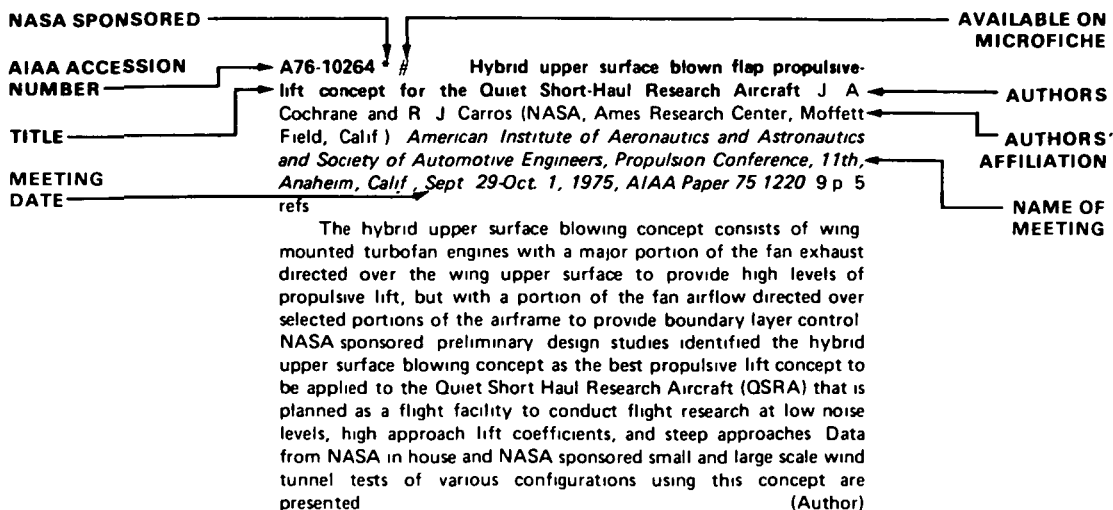
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## TYPICAL CITATION AND ABSTRACT FROM IAA



# AERONAUTICAL ENGINEERING

*A Special Bibliography (Suppl. 72)*

JULY 1976

## IAA ENTRIES

**A76-25758 #** The pulsed thermocouple for gas turbine application D Kretschmer, J Odgers, and A F Schlader (Université Laval, Quebec, Canada) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-1* 10 p 14 refs Members, \$150, nonmembers, \$300 Research sponsored by the National Research Council of Canada

A mechanically pulsed suction thermocouple has been developed. The gas to be measured is sucked through a sonic orifice, eliminating the influence of the velocity inside the combustor. The signal from the thermocouple is processed by an analogue circuit. A calibration of the probe was done. This calibration showed very little scatter and a good repeatability. The overall measurement accuracy was better than 1 percent. As a test of application, a partial survey of the temperature distribution within an aircraft gas turbine combustor was done. A satisfactory agreement was observed between temperatures measured by the thermocouple and those determined from gas analysis. The pulse thermocouple proved to be a reliable and fast tool for the measurement of local gas temperatures (Author)

**A76-25773 #** An experimental determination of the unsteady aerodynamics in a controlled oscillating cascade S Fleeter, A S Novick, R E Riffel, and J E Caruthers (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-17* 9 p 9 refs Members, \$150, nonmembers, \$300 Contract No N00014-72-C-0351

A unique supersonic inlet flow field unsteady cascade experiment is described wherein the time dependent pressure distribution within an harmonically oscillating airfoil cascade is quantitatively determined. The torsional frequency of oscillation and the interblade phase angle are precisely controlled by means of on-line digital computers. The dynamic data obtained include the chordwise distribution of the unsteady pressure magnitude and its phase lag as referenced to the airfoil motion. Parameters varied include the cascade inlet Mach number, the interblade phase angle, and the reduced frequency. The time-dependent data are correlated with state-of-the-art analytical predictions (Author)

**A76-25781 #** Composite inlays increase flutter resistance of turbine engine fan blades. W Troha (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and K Swain (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-29* 8 p Members, \$150, nonmembers, \$300

A method for improving turbine engine blade flutter stability has been demonstrated on a TF41 fan rig and engine. The concept uses the high strength and stiffness properties of B/SiC-titanium composite, bonded into the leading edge tip section of a titanium fan

blade, to control the blade vibrational characteristics. Comparisons are made between the blade response characteristics with and without the composite inlay for blade natural frequency, untwist due to rotational speed, and shift in flutter boundary. Engine performance improvements due to shroud removal are also shown (Author)

**A76-25786 #** Advanced Acoustic Nacelle concepts G W Painter (Lockheed-California Co., Burbank, Calif.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-35* 10 p 9 refs Members, \$150, nonmembers, \$300

The results of a recently completed study on the potential noise-reduction benefits that could be derived from the development of an 'Advanced Acoustic-Composite Nacelle' for future subsonic commercial transports are discussed. In this study, noise-reduction objectives were based on the acceptance of noise floors imposed by airframe noise during approach operation and jet noise during takeoff. The reduction of treatable source levels to these floors should result in aircraft noise levels below those of the already quiet current widebodied transports. It is predicted that the foregoing noise levels can be achieved in future widebodied transports by employing advanced acoustical duct liners, extending the (lined) fan duct, and incorporating jet mixing (Author)

**A76-25792 #** Coupled bending-torsion vibrations of rotating blades S Banerjee and J S Rao (Indian Institute of Technology, Kharagpur, India) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-43* 14 p 41 refs Members, \$150, nonmembers, \$300

This paper presents analytical and experimental investigations to determine the coupled bending-torsion natural frequencies of cantilever blades mounted on a rotating disk. Galerkin method is applied to solve the coupled differential equations of motion for an aerofoil cross section blade with asymmetry about only one principal axis. The blade is considered to be mounted with the axis of symmetry in the plane of disk rotation. Results obtained are presented in non-dimensional form, showing the effects of rotation, disk radius, and asymmetry on the lowest three-coupled bending and lowest three-coupled torsion frequencies. An experimental rig is designed and fabricated to test rotating blades using piezoelectric crystals to excite the blades and also to pick up the response. The theoretical results are shown to be in good agreement with experimental observations (Author)

**A76-25812 #** Noise technology requirements for future aircraft powerplants J D Kester and A A Peracchio (United Technologies Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La, Mar 21-25, 1976, Paper 76-GT-69* 14 p 17 refs Members, \$150, nonmembers, \$300

Noise technology requirements are surveyed for several future aircraft powerplants. The applications considered range from growth versions of current production engines to future advanced supersonic transport applications. Although a variety of complex and challenging noise-suppression problems are identified, a sampling of several basic problems common to a variety of engine designs are

discussed in more detail. Among these are the prediction of fan noise generation and propagation in treated ducts, the use of mixer nozzles to reduce jet exhaust noise, and the prediction and absorption of combustion noise. Discussed in the paper are analytical and experimental approaches applicable to solving these problems.

(Author)

**A76-25813 # Inflight engine performance evaluations** W E Beck, Jr (Lockheed California Co., Burbank, Calif.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-70* 11 p. Members, \$1 50, nonmembers, \$3 00

The measurement and determination of installed in-flight engine performance on an aircraft are complex tasks. To be successful requires that wind-tunnel-model and full-scale in-flight test programs be fully planned early in the development phase of the aircraft design. In particular, methodology and instrumentation requirements must be coordinated in these programs. This paper discusses the requirements and methodology for in-flight engine performance evaluations as applied to a subsonic antisubmarine-warfare aircraft. Data are presented which show that two independent methods of calculating steady-state engine net thrust levels agree to within plus or minus 1.5 percent of each other over the full operating regime of the aircraft. Finally, comparisons of calculated performance with that predicted from the engine manufacturer's cycle deck are presented.

(Author)

**A76-25814 # A multi-variable control for a turbofan engine operating at sea level static** M S Weinberg (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-71* 10 p. 8 refs. Members, \$1 50, nonmembers, \$3 00

Based on modern control theory, a multi-variable control is formulated for a two-spool turbofan engine operating at sea level static conditions. The proposed control yields idle to intermediate transients in 40 percent of the time required by the conventional controls in non-linear simulations while maintaining similar stall and temperature overshoot characteristics. The formulated control is simpler than earlier proposed multi-variable controls and yields acceptable performance during small thrust changes and decelerations.

(Author)

**A76-25818 # Advanced composite fan blade flight evaluation program** M H Chopin (USAF, Aeronautical Systems Div Wright Patterson AFB, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-75* 6 p. Members, \$1 50, nonmembers, \$3 00

The preparation for and conduct of the first flight by the U.S. Air Force of a turbine engine fan stage fabricated of advanced composite materials is discussed. Composite material properties and basic design philosophy is presented along with preliminary flight evaluation results. This is the first application of filamentary-reinforced metal matrix composites to a turbine engine structural component.

(Author)

**A76-25821 # CFM56 turbofan engines - General Electric/SNECMA cooperative engineering development program** E Caffier (CFM56 SNECMA, Moissy-Cramayel, Seine-et-Marne, France) and A O Kohn (General Electric Co., CFM56 Dept., Evandale, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-78* 8 p. Members, \$1 50, nonmembers, \$3 00

A joint company has been formed by the General Electric Company, U.S., and the Societe Nationale d'Etude et de Construction de Moteurs d'Aviation (SNECMA), France, to develop a 'ten-ton' high bypass turbofan engine for commercial and military use. The engine, designated CFM56, is based to a large extent on the core of the F101 engine which powers the B-1 bomber. Hardware

design and development initiated in 1973 has led to the construction of four test engines. Management of the engineering aspects of the development program is discussed, and the division of responsibilities, interface definition and control, integration and communications and security procedures are described.

C K D

**A76-25825 # A new system for preventing icing of gas turbine inlets** G R Gillingham (Donaldson Co., Inc., Minneapolis, Minn.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-84* 6 p. 5 refs. Members, \$1 50, nonmembers, \$3 00

A new system for preventing condensate and precipitate icing of gas turbine inlet systems has been developed. This system uses a combination heat exchanger/moisture separator called an Anti-Ice Moisture Separator (AIMS) to provide icing protection without the need to heat the inlet air to 0 C or above. Turbine exhaust gas heats the AIMS surfaces and thereby prevents ice from forming on them. Turbine inlet air passing over these surfaces is heated by convection. No mixing of exhaust gas with inlet air occurs. Condensate icing is prevented by heating the air enough to prevent it from falling below the dew point temperature anywhere in the inlet system. Precipitate icing is prevented by separating most water droplets from the inlet air and evaporating the rest before they impact and freeze on cold surfaces. The AIMS system has successfully prevented turbine inlet icing in temperatures as low as -22 C (-8 F) during field tests. It is anticipated that AIMS systems will be able to prevent inlet icing at any ambient temperature that may be encountered.

(Author)

**A76-25829 # High performance epicyclic gears for gas turbines** D E Imwalle (Cincinnati Gear Co., Cincinnati, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-88* 11 p. Members, \$1 50, nonmembers, \$3 00

The history and explanation of the Cinti-BHS load equalization system for epicyclic gears is discussed in detail. Equations for relating gearbox size and weight are presented for parallel shaft and epicyclic gears. A derivation for the maximum ratio for the number of planets is also included.

(Author)

**A76-25833 # Primary system preliminary design for gas turbine HTGR power plant** C F McDonald, P Fortescue, and J M Kruse (General Atomic Co., San Diego, Calif.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-92* 16 p. 11 refs. Members, \$1 50, nonmembers, \$3 00

The gas-turbine high-temperature gas-cooled reactor (GT-HTGR) power plant combines the existing HTGR core with a closed-cycle helium gas turbine power-conversion system directly in the reactor primary circuit. An integrated design concept in which the reactor core, turbomachinery, heat exchangers, and entire helium inventory are enclosed within the prestressed concrete reactor vessel (PCRV) was selected on the basis of both safety and economic reasons. The layout of the power-conversion loop (PCL) components, with envelope restraints associated with installation in cavities in the PCRV, and development of the primary-system gas-flow paths are discussed. This paper outlines the studies which led to the selection of the primary system for an integrated type of plant embodying multiple gas-turbine loops. With orientation and configuration of the major components in the PCL forming the basis of these studies, some of the preliminary design considerations for the turbomachinery, heat exchangers, and other components are discussed.

(Author)

**A76-25835 # Aerodynamics and heat transfer at the trailing edge of transonic blades** O M Amana, H O Demuren, J F Louis (MIT, Cambridge, Mass.), C Sieverding, and J Chauvin (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-95* 14 p. 15 refs. Members, \$1 50, nonmembers, \$3 00. Contract No. N00014-67-A-0204-0079

A base flow model has been proposed which, apart from predicting the base pressure, also predicts the wake angle and the trailing edge shock system to a good degree of accuracy. The method may also handle a round trailing edge which is important in transonic blades for reducing losses. The base pressure found in the above is then used in the prediction of some of the parameters in the heat-transfer model. The trailing edge heat-transfer model explains and correlates experimental data, for film cooling the trailing edge, obtained using short duration techniques. The results show that film cooling may be used in cooling the trailing edges of transonic blades effectively, provided that the coolant port is located just beyond a critical distance upstream of the trailing edge. The critical distance is the distance required for the coolant flow which separates at injection to reattach downstream and depends on the momentum ratio of coolant to mainstream flows, on the angle of injection, and the flow Reynolds number (Author)

**A76-25837 # Control of a gas turbine HTGR** F Openshaw, E Estrine, and M Croft (General Atomic Co., San Diego, Calif.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-97* 12 p 7 refs. Members, \$1 50, nonmembers, \$3 00. Contract No. E(04-3)-167 ERDA Project 46

This paper presents a description of the control and protective preliminary system designs for the gas turbine high-temperature gas-cooled reactor power plant (GT-HTGR). The purpose of these systems is the control and safe operation of the plant in accordance with utility practice for large nuclear generation stations, and in the event of an abnormal or accident condition to shut the plant down in an orderly manner and maintain it in a safe shutdown condition. The control system is designed to regulate reactor power, control electric load and turbine speed, control the temperature of the helium delivered to the turbines, and control thermal transients experienced by reactor internal components. In addition, it provides the required control and programming for start-up, shutdown, load ramp, and other expected operations. The control system also handles conditions imposed on the system during upset and emergency conditions. Under these conditions, reactor power and helium flow are reduced in order to minimize temperature transients imposed on reactor components. The transient analysis and control system selection process which has been used to establish the reference GT-HTGR control system is illustrated in this paper (Author)

**A76-26049 # Economics of air transport (Ekonomika grazhdanskoi aviatsii)** A V Miroshnikov, I I Spotkai, N N Gromov, E V Makarov, G S Dibrova, E F Busalov, and A Ia Chernyshev. Moscow, Izdatel'stvo Transport, 1975. 304 p. 53 refs. In Russian.

The book evaluates and characterizes in detail the role of air transport in the general transportation picture as well as the whole national economy. Most of the details apply to the Soviet economy and air transport system, though it is attempted to extend the discussion to general economies. Topics covered include the organization of the control of civil aviation, civil aviation planning principles, management of main civil aviation funds, indices and means of increasing the efficiency of the use of main funds, structure, normalization, and turnover of working capital, productivity and a system for remuneration of labor in civil aviation, material incentive systems, labor and salary planning, methods for determining prime costs in civil aviation, construction of tariff systems, comparison of expenditures and intakes and securing profitability, economic effectiveness of capital investments, and methods for determining the economic effectiveness of aircraft and engine utilization and of the introduction of new types of aircraft. P T H

**A76-25851 # The potential of oxide dispersion strengthened superalloys for advanced gas turbines** J S Oenjin (International Nickel Co., Inc., Suffern, N.Y.) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-118* 10 p. 18 refs. Members, \$1 50, nonmembers, \$3 00.

Both the performance and life of gas turbines are frequently

controlled by properties of materials in critical components. The different properties required simultaneously for a given part have placed extreme demands on conventional wrought or cast nickel-base superalloys. The recently developed mechanical alloying process has allowed achievement of a new combination of important properties, such as oxidation resistance, sulfidation resistance, and elevated temperature rupture strength. The interaction between the unique stress/temperature/time behavior of an oxide dispersion strengthened superalloy and blade configuration is treated. Significant potential for improvements in gas turbine performance is found based on a simplified energy exchange model (Author)

**A76-25855 # XfV-12A propulsion system development** J T Delany and G M Jenkins (Rockwell International Corp., Columbus Aircraft Div., Columbus, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 76-GT-125* 15 p. Members, \$1 50, nonmembers, \$3 00. Navy-supported research.

The XfV-12A total powered lift/thrust system being developed under contract for the U.S. Navy is described. The description includes design and development to date of the inlets, engine integration, the diverter valve with plug nozzle, the lift system augmentor supply ducting, and lift/thrust augmentor hardware. The development process description includes system design philosophy and criteria, analysis, test facilities utilized, model and full scale testing and evaluation (Author)

**A76-25875 \* # Advanced turbine disk designs to increase reliability of aircraft engines** A Kaufman (NASA, Lewis Research Center, Cleveland, Ohio) *American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, New Orleans, La., Mar 21-25, 1976, Paper 32* p. NASA-supported research.

Results of analytical studies to improve the low cycle fatigue lives and reliability of turbine disks in high performance gas turbine engines are presented. Advanced disk concepts were evaluated for the first-stage high pressure turbines of the CF6 50 and JT8D-17 engines. The advanced disk designs are compared to the existing disks on the bases of cycles to crack initiation and overspeed capability for initially unflawed disks, crack propagation cycles to failure for initially flawed disks, and available kinetic energy of disk burst fragments (Author)

**A76-26048 # Engineering aspects of flight safety (Tekhnicheskie voprosy obespecheniya bezopasnosti poletov)** P A Solomonov. Moscow, Voenizdat, 1975. 119 p. 21 refs. In Russian.

The principal factors affecting flight safety are discussed, and methods that can be used to obtain quantitative flight safety estimates are reviewed. Attention is given to factors which must be taken into consideration in the design and development of reliable aircraft, and to onboard instruments which help the pilot to maintain a high safety level during flight. Techniques used to determine the causes of flight accidents are described. V P

**A76-26049 # Economics of air transport (Ekonomika grazhdanskoi aviatsii)** A V Miroshnikov, I I Spotkai, N N Gromov, E V Makarov, G S Dibrova, E F Busalov, and A Ia Chernyshev. Moscow, Izdatel'stvo Transport, 1975. 304 p. 53 refs. In Russian.

The book evaluates and characterizes in detail the role of air transport in the general transportation picture as well as the whole national economy. Most of the details apply to the Soviet economy and air transport system, though it is attempted to extend the discussion to general economies. Topics covered include the organization of the control of civil aviation, civil aviation planning principles, management of main civil aviation funds, indices and means of increasing the efficiency of the use of main funds, structure, normalization, and turnover of working capital, productivity and a system for remuneration of labor in civil aviation, material incentive systems, labor and salary planning, methods for determining prime costs in civil aviation, construction of tariff systems, comparison of expenditures and intakes and securing profitability, economic effec-

tiveness of capital investments, and methods for determining the economic effectiveness of aircraft and engine utilization and of the introduction of new types of aircraft P T H

**A76-26337 #** Asymptotic representation of solutions on the hodograph plane in problems of subsonic flow past airfoil profiles (Ob asimptoticheskom predstavlenii reshenii na ploskosti godografa v zadachakh okolozvukovogo obtekaniia profilei) Z N Dobrovolskaia *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Jan-Feb 1976, p 84-88 9 refs In Russian

The steady plane-parallel transonic flow of an ideal gas past a slender body is examined. The behavior of the perturbed flow in the region upstream from the shock waves at large distances from the body is analyzed. The conditions are determined that are satisfied by a solution on the hodograph plane, which corresponds to a flow without singularities on the limiting characteristic in the physical plane of the flow. The transonic flow at large distances from the body is described by Karman's approximate equation V P

**A76-26338 #** Optimal supersonic wing profile of given thickening (Ob optimal'nom sverkhzvukovom profile zadannogo utolscheniia) V I Zubov *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Jan-Feb 1976, p 89-96 6 refs In Russian

The problem of designing a closed profile for minimum wave drag in uniform supersonic flow is analyzed, assuming that the length and thickness of the profile and the angle of attack are prescribed. The analysis is limited to bodies with attached shock waves. Solutions are obtained for exact and model formulations of the problem. Numerical data are presented V P

**A76-26339 #** Interaction between an external shock wave and a blunted body in hypersonic flow (O vzaimodeistvii vneshnego skachka uplotneniia s zatuplennym telom v giperzvukovom potoke) G A Shmanenkova *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Jan-Feb 1976, p 97-103 6 refs In Russian

A complex shock wave configuration with two triple points can result from the interaction between an oblique shock wave and a separated shock wave in front of a blunted body (such as the wing leading edge). This may lead to the formation of a high-pressure low entropy stream filament. The flow regimes that correspond to these conditions are studied analytically and experimentally. An approximate method is proposed for determining the size of shock wave separations in the interaction region V P

**A76-26384 \*** An aircraft noise pollution model for trajectory optimization A Barkana (DMMA, Eskisehir, Turkey) and G Cook (Virginia, University, Charlottesville, Va) *IEEE Transactions on Aerospace and Electronic Systems*, vol AES-12, Mar 1976, p 109-116 Contract No NAS1-10210-8

A mathematical model describing the generation of aircraft noise is developed with the ultimate purpose of reducing noise (noise-optimizing landing trajectories) in terminal areas. While the model is for a specific aircraft (Boeing 737), the methodology would be applicable to a wide variety of aircraft. The model is used to obtain a footprint on the ground inside of which the noise level is at or above 70 dB B J

**A76-26412** New developments in aeronautics technology (Nouveaux développements de la technologie aéronautique) J Pitrou *Matériaux et Techniques*, vol 64, Jan-Feb 1976, p 34-36 In French

The mechanical characteristics and applications of materials recently developed for use by the aviation industry are discussed. Among the materials described are high-resistance steels, the high-tensile strength alloy HP310, the nickel-chromium-copper alloy X12-6PH, the aluminum alloys 7049, 7050, and 7475, copper zirconium and copper-chromium alloys, and copper materials containing finely dispersed refractory oxides to improve the mechanical characteristics at temperatures around 200 C. The advantages of the

organic fiber Kevlar-49 and of epoxy-graphite resins are outlined. Developments in machining, fabrication, and finishing techniques are detailed C K D

**A76-26450** Dynamics of helicopter flight G H Saunders (Southern California, University, Los Angeles, Calif) New York, Wiley-Interscience, 1975 313 p 102 refs \$16 95

Dynamics of hovering and forward flight of helicopters is described on the basis of fundamental concepts of mechanics and essential laws of aerodynamics. The means by which the main rotor system of a helicopter derives lift while hovering in calm air are examined. Particular attention is devoted to the stability and control of modern helicopters, including the rapidly advancing application of stability augmentation concepts to helicopters. Some flying problems are examined from the pilot's standpoint, with special emphasis on autorotation maneuver, operation at high gross weight and density altitude, external sling load, instrument flying, winds and turbulence, retreating blade stall, and wake turbulence. Elements of helicopter structures from strength requirements to crashworthiness are also discussed S D

**A76-26550 #** Types and ideal propulsive efficiency of aeronautical propulsion systems (Denominazioni e rendimento propulsivo ideale dei motopropulsori aeronautici) G Gabrielli *Ingegneria*, Jan-Feb 1976, p 1-14 In Italian

A classification of propulsion systems, ranging from propeller engines to rocket engines, is given. The basic parameters and relations characterizing ideal propulsion are set forth, and some dimensionless factors are indicated which determine ideal propulsion on the hypothesis of constant translational velocity. Graphs are drawn which show the effect of individual parameters on ideal efficiency for propeller engines, gas turbine engines, and rocket engines P T H

**A76-26584** Heat transfer in high-temperature GTE air-cooled turbine blades V I Lokai (*Aviatsionnaia Tekhnika*, vol 18, no 3, 1975, p 60-68) *Soviet Aeronautics*, vol 18, no 3, 1975, p 41-47 20 refs Translation

In the calculation of internally air cooled turbine blades, the boundary conditions of heat transfer from the gas and air are conventionally established on the basis of similarity equations derived from static test data. In the present analysis, the necessity is demonstrated to take into consideration such factors as the influence of the rotor's rotational speed on heat transfer intensity, the emission from the gas, the angle of incidence, etc. Expressions for evaluating these factors numerically are proposed. It is shown that heat transfer characteristics obtained indirectly from measurements of the mean blade wall temperature are not reliable V P

**A76-26648 #** Windshield Flight Environment Simulator L G Campbell and J W Marshall (Sierracin Corp, Sylmar, Calif) *Aircraft Engineering*, vol 48, Mar 1976, p 4-9

The Windshield Flight Environment Simulator (WFES), which reproduces the total operating environment of electrically-heated, pressurized aircraft windshields on a highly compressed time scale, is discussed. The facility has been used in the development and improvement of the 747 windshield and is easily modified to allow testing of other windshield installations. It has been operated to the following limits at a near-sea-level elevation: airspeed over windshield, 0-200 knots; maximum heat transfer coefficient, 35 BTU/hr/sq ft/deg F; outside air temperature, 100 to +150 deg F; cabin pressure differential, 15 psi. The system utilizes liquid nitrogen cooling. The windshield can be observed visually and photographically during testing, and instrumentation is provided for the display and recording of deflections, temperature, pressures, current, and voltages C K D

**A76-26650 # Thrust reverser design for airframe compatibility** J M D Sutton (Rolls Royce /1971/, Ltd, London, England). *Aircraft Engineering*, vol 48, Mar 1976, p 16-20

Aerodynamic design considerations involved in the optimization of thrust reverser configurations are examined. For cascaded designs a synthesis of the overall fan reverser configuration can be obtained by successive iteration using individual model cascades correlated against aerodynamic loading. For a given target reverser design, the reverse thrust and isolated nozzle suppression are predicted from generalized model data. The aerodynamic design considerations for thrust reversal are dependent on the initial definition of an acceptable installed discharge pattern rather than reverser type.

C K D

**A76-26670 Propulsion systems (Triebwerksanlagen)** W Alvermann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Antriebssysteme, Braunschweig, West Germany) *VDI-Z*, vol 118, no 6, Mar 1976, p 287-291. 41 refs. In German.

The current status of development of aircraft engines is examined, taking into account a search for new fuels, economic demands for aircraft engines, the development of new engines with more favorable environmental characteristics, plans for the development of an acceptable engine for supersonic aircraft, and general studies concerned with the enhancement of the operational efficiency of the engine. Attention is given to current and future jet engines, turbine engines for helicopters, piston engines, and ramjet engines.

G R

**A76-26751 Swept edge to reduce the noise generated by turbulent flow over the edge** L Filler (Boeing Commercial Airplane Co., Seattle, Wash.) *Acoustical Society of America, Journal*, vol 59, Mar 1976, p 697-699. 6 refs.

When turbulent fluid flows over an edge, swept at an angle ( $\alpha$ ) to the flow direction, it is shown from simple physical arguments that the radiated sound intensity can be reduced by at least a factor of  $\cos \alpha$ . The anticipated sound reduction depends on the assumption that the normal component of turbulent momentum convected over the edge is the dominant contributor to the edge interaction noise mechanism at high Reynolds numbers. Some preliminary experimental results which confirm the noise reduction are presented for a jet flowing over an edge swept in a sawtooth configuration.

(Author)

**A76-27068 Can R-W aircraft provide efficient commercial transport.** R H Miller (MIT, Cambridge, Mass.) *Vertiflite*, vol 22, Jan-Feb 1976, p. 4-7

Contributions by a panel of experts on the outlook for short-haul applications in transportation by rotary-wing aircraft are summarized. While the fuel efficiency of rotary-wing aircraft is only 50% that of fixed-wing aircraft, improvements in rotor profile design, elimination of parasite drag and induced drag, advanced rotor systems, and improvements in structures, aerodynamics, and propulsion are expected to narrow the gap. Rotary-wing aircraft offer most efficient utilization of terminal real estate, plus savings in time in interterminal hops (surpassing road vehicles and rail vehicles). Possible speed advantages with tilt-rotor aircraft are considered.

R D V

**A76-27144 An update - Advanced aircraft oxygen systems** A J Adduci (USAF, Life Support Systems Program Office, Wright-Patterson AFB, Ohio) *SAFE Journal*, vol 6, Spring 1976, p 16-19

This paper updates a report given at the Annual Survival and Flight Equipment Association Conference in 1973. The advancements in oxygen systems described concern physiological safety as well as reduction in total system cost. The cost savings are in servicing and maintenance, as opposed to the acquisition cost. Life cost savings are achieved by eliminating the use of liquid oxygen. The discussion covers two categories of oxygen systems, systems of the type that must be used constantly or intermittently during flight in order to perform the flight mission, and systems used in emergency

situations (including therapeutic oxygen systems). Particular attention is given to the Air Force C-5A passenger oxygen system and the helicopter oxygen system, as well as to an oxygen sorbent system equipped with a chemical that has a useful life of acceptable length. The problems which plagued a system of oxygen extraction by electrochemistry appear to have been overcome.

V P

**A76-27274 \* # Some considerations in the design of transport aircraft /The W. Rupert Turnbull Lecture for 1975/** R T Jones (NASA, Ames Research Center, Moffett Field, Calif.) (*Canadian Aeronautics and Space Institute, Annual General Meeting, Montreal, Canada, May 13, 1975*) *Canadian Aeronautics and Space Journal*, vol 21, Nov 1975, p 332-337

The slow landing speeds (30 mph, 65 mph) and light wing loading required for safety in the early days of aviation are shown to be irrelevant to safe landings of propeller driven aircraft, while increases in wing loading and landing speed have been accompanied by improved safety records. This is attributed to length of runway and time available for approach maneuvers, plus immunity to wind gusts and turbulence conferred by higher wing loadings. Aerodynamical and mechanical aspects of safe landing are discussed, with no mention of instruments. Fuel savings achievable through high aspect ratio, variable sweep angle, and supercritical airfoils are also considered.

R D V

**A76-27328 Iterative calculation of two-dimensional compressible flow around ellipse and circular arc profile (Iterative Berechnung der ebenen, kompressiblen Strömung um Ellipse und Kreisbogenzweieck)** K Kern and R Mader (München, Fachhochschule, Munich, West Germany) *Acta Mechanica*, vol 24, no 1-2, 1976, p 47-61. 11 refs. In German.

Starting from incompressible flow, the irrotational plane flow of a perfect gas past both an ellipse and a circular arc profile is calculated using an iteration-method developed by Sauer (1952). No expansion of the flow potential in powers of any parameter is made. As the results show, the method works correctly even for speeds of the undisturbed flow slightly greater than the critical speed. The method is computer-oriented and useful for all profiles which allow conformal mapping onto the circle.

(Author)

**A76-27329 A linearized theory of three-dimensional airfoils in nonuniform flow** D Homencovschi and A Barsony-Nagy (Bucuresti, Institutul Politehnic, Bucharest, Rumania) *Acta Mechanica*, vol 24, no 1-2, 1976, p 63-86. 9 refs.

Linearized steady motion of a three-dimensional airfoil in a fluid flow whose velocity at infinity has a two-dimensional distribution is considered. The starting point of the analysis is the equations in distributions characterizing the fluid motion. The solution of the disturbance velocity is represented in the Fourier transform plane and its asymptotic behavior is studied. The integrodifferential equation of the problem is transformed into an equivalent equation with a strong singularity. The singular part of the kernel of this equation coincides with the kernel of the corresponding equation for uniform flow. The disturbance velocity components  $u$  and  $v$  are studied at infinity, and the existence of the disturbance velocity downstream of the airfoil is shown. The expression for the velocity jump when crossing this surface is in agreement with Prandtl's hypotheses concerning free vortices. Attention is given to lifting segment theory in nonuniform flow, and analog to Prandtl's equation is derived. Its kernel differs from the kernel of Prandtl's equation by a term with a weak singularity which depends only on the velocity distribution at infinity.

P T H

**A76-27361 # Some basic questions concerning quality assurance in aircraft maintenance (Über einige Grundfragen der Qualitätssicherung in der Flugzeuginstandhaltung)** P Bork (Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 12, no 1, 1976, p 14-23. In German.

The significance of the quality concept from the point of view of aircraft maintenance is considered and aspects of quality

definition and evaluation are investigated. The approaches used in the areas of quality assurance and quality control are discussed and a table is provided with elements of the quality assurance system used for the technical operation of aircraft. Attention is also given to suitable organization and educational procedures for improving quality and avoiding cases of faulty performance. G R

**A76-27362 # Quality assurance by standardization (Qualitätssicherung durch Standardisierung)** H Nicklisch (Kombinat Spezialtechnik, Dresden, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 12, no 1, 1976, p 24-28. In German.

A number of relations between aspects of quality assurance and standardization are discussed, taking into account the effect of standardization procedures in operations related to the maintenance of aircraft and the manufacture of spare parts. Basic problems and questions of methodology are examined and the standardization of the materials of aerospace technology is considered. A brief description is given of an analysis of technological processes. The analysis had been conducted in connection with occasionally occurring defects concerning the quality of spare parts. It is proposed to review the specifications periodically to avoid a detrimental effect of standardization on technological progress. G R

**A76-27363 # Licensing and the organization of the servicing process in aircraft maintenance (Erlaubniswesen und Organisation des Wartungsprozesses in der Flugzeuginstandhaltung)** H Bremer (Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 12, no 1, 1976, p 39-46. In German.

The currently used system of aircraft maintenance in the German Democratic Republic is briefly analyzed and compared with other systems. The investigation is to provide information concerning the approaches which can be used for a more effective utilization of the available maintenance personnel. The aircraft is examined from the viewpoint of systems analysis as an aggregate of various subsystems. Advantages and drawbacks of the current maintenance system are discussed. The qualifications and the general status of the training of the technical maintenance expert in relation to the range of his assigned duties are considered, taking into account the characteristics of a system in which the expert is only authorized to work with one type of aircraft. G R

**A76-27364 # Determination of the realizable flight hours for aircraft (Bestimmung der realisierbaren Flugstunden von Flugzeugen)** K Tomov, J Bobev, and V Boiadzhiev. *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 12, no 1, 1976, p 56-63. In German. (Translation)

A method is derived for the calculation of the maximum number of flight hours which can be obtained in a year in the case of an airliner. It is pointed out that at the present time it is not possible to take into account a number of secondary conditions. The described method should, therefore, be considered as an intermediate step on the way to a more perfect evaluation procedure. G R

**A76-27741 # Non-linear effect due to flow separation on flow past wings and wing body combinations** S V Ramakrishnan and N R Subramanian (Indian Institute of Technology, Madras, India) In *Nonlinear Ballistics Seminar*, Pune, India, June 21, 22, 1974, Proceedings. Pune, India, Institute of Armament Technology, 1975, p 183-190.

The nonlinear phenomenon of flow separation from a slender delta wing in a conical supersonic flow is studied in the cross flow plane. An inviscid model is constructed by introducing the vortex sheet as a free boundary in the form of a spiral. All the vorticity in the fluid is assumed to be contained in this sheet, so that motion outside is irrotational. The entire inner part of the sheet is replaced by a line vortex. Shape of the vortex sheet, strength of the vortex sheet, position of the vortex core, and strength of the vortex core can then be found by simultaneous solution of the boundary

conditions and the equations for the smooth outflow condition and the condition of zero total force on the vortex. The method is extended to wing-body combinations, where the wing-body is transformed into a vertical slit. P T H

**A76-27743 # Ballistics of ejection seats** M R Patkar (Armament Research and Development Establishment, Pune, India) In *Nonlinear Ballistics Seminar*, Pune, India, June 21, 22, 1974, Proceedings. Pune, India, Institute of Armament Technology, 1975, p 241-258, Discussion, p 259-260. 10 refs.

The paper reviews the evolution of ejection seats and then gives a state-of-the-art description of the ballistics of ejection with emphasis on pilot safety considerations. A method for calculating the trajectory of ejection seats for given initial data on ejection velocity, ejection angle, and flight envelope is outlined. Cartridge and propellant design are examined from the viewpoint that they should be such as to ensure an ejection velocity of about 80 ft/sec, peak accelerations of not more than 25 g, and rate of rise of acceleration not exceeding 300 g/sec. An experimental technique for evaluating ballistic parameters of ejection seats is described. Initial development of a vented vessel and final development of a 154-foot seat ejection tower with associated instrumentation are discussed. P T H

**A76-27826 Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings** Symposium sponsored by IUTAM, DFG, DFVLR, AFSC, U.S. Army, et al. Edited by K Oswatitsch (Wien, Technische Hochschule, Vienna, Austria) and D Rues (Aerodynamische Versuchsanstalt, Gottingen, West Germany). Berlin, Springer-Verlag, 1976. 590 p. In English and German. \$36.10.

Investigations in the area of unsteady flow are examined, taking into account asymptotic solutions for nonsteady transonic channel flows, shock oscillations in transonic flows and their prevention, a calculation of buffet onset for supercritical airfoils, and unsteady transonic supersonic flow over suddenly inserted bodies. Hodograph methods are considered along with methods in the physical space, studies of internal flow, investigations of viscous flow, and various applications. Descriptions of numerical methods are also provided, giving attention to numerical techniques for calculating supercritical airfoil flows, steady transonic flow through plane and axisymmetric nozzles, and a calculation of steady inviscid flow around nonlifting bodies.

G R

**A76-27827 Some developments in unsteady transonic flow research** M T Landahl (Kungl Tekniska Hogskolan, Stockholm, Sweden, MIT, Cambridge, Mass.) In *Symposium Transonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings*. Berlin, Springer-Verlag, 1976, p 1-32. 37 refs.

Some important properties of unsteady transonic flows are considered along with recent developments of methods for calculating oscillatory transonic flows and a procedure for finding the solution for an oscillatory source imbedded in a steady, nonuniform transonic potential flow. It is pointed out that the validity of the linearized theory is intimately connected with the stability of a steady transonic flow. Questions of flow stability are investigated. Attention is given to the solution of the linearized flow problem of a three-dimensional wing performing infinitesimal oscillations, taking into account an approach which employs the method of parametric differentiation. G R

**A76-27830 On the motion of shock waves on an airfoil with oscillating flap** H Tijdeman (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands) In *Symposium Transonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings*. Berlin, Springer-Verlag, 1976, p 49-56. 6 refs.

Results are presented of measurements of the periodical motion of the shock waves on a NACA 64A006 airfoil with harmonically oscillating flap in two-dimensional attached transonic flow. It is



shown that three different types of shock wave motion can be distinguished. An analytical model is developed, with which a satisfactory explanation can be given of the observed types of shock wave motion. (Author)

**A76-27832** Calculation of buffet onset for supercritical airfoils G Redeker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer Verlag, 1976, p 66-74 12 refs

The method of Thomas (1971) for calculating buffet onset has been improved in such a way that supercritical airfoils as well as high angles of attack and high lift coefficients can be treated. Calculated examples of buffet onset boundaries are shown and compared with experimental results (Author)

**A76-27837** Review of the application of hodograph theory to transonic aerofoil design and theoretical and experimental analysis of shock-free aerofoils J W Boerstel (National Luchtvaart laboratorium, Amsterdam, Netherlands) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 109-133 29 refs. Research supported by the Netherlands Agency for Aerospace Programs

Hodograph theory is concerned with a flow which is plane and irrotational. It is assumed that the flow satisfies the mass conservation law, Bernoulli's law, and a pressure-density relation. The flow equations are transformed to hodograph equations by assuming that there exists a mapping from a physical plane to a surface called the hodograph surface. The partial differential equations obtained are linear. Computational design techniques for shock-free airfoils are discussed. In a review of the applications of the theory attention is given to the experimental existence of shock-free flow, examples of airfoils computed with advanced hodographic methods, the pressure distributions in the design condition, the maximum thickness of shock-free airfoils, and leading edge shapes and low drag. G R

**A76-27838** The direct problem of the transonic airfoils on the hodograph. S Nocilla, G Geymonat (Torino, Politecnico, Turin, Italy), and B Gabutti (Torino, Università, Turin, Italy) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer Verlag, 1976, p 134-141 23 refs

The transonic shock-free flow past a given profile is here calculated with a direct procedure on the hodograph plane. The numerical results relative to the circular arc with various leading edges are presented and discussed (Author)

**A76-27844** Airfoil design for a prescribed velocity distribution in transonic flow by an integral method H Hansen (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 183-190, 5 refs

In the present paper a method for the design of airfoils for a prescribed transonic contour velocity distribution is developed. It applies the fundamental ideas of the integral method after K. Oswatitsch for the prediction of the velocity distribution on a given airfoil in nonlinear compressible flow. (Author)

**A76-27855** Design and test of a sonic roof-top pressure distribution wing. A L Gustavsson and S G Hedman (Forsvarsdepartementet Flygtekniska Forsöksanstalten, Bromma, Sweden) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 273-280 6 refs

The PT2 wind tunnel model is a moderate aspect ratio wing of 'sonic roof-top design'. It was designed employing the Woodward

panel method (used to calculate camber and twist distribution) and has straight isobars and a plateau with local Mach number equal to one in the design point. Balance tests and pressure measurements were performed on the model at a Reynolds number of  $1 \times 10^6$  to the 6. The measured pressures show that the flow is supercritical with a strong shock outwards from midspan with more lift towards the tip than was calculated. The transonic relaxation method was applied to a preliminary redesign of the wing. B J

**A76-27856** Supercritical wing design for a fighter type experimental aircraft. R. Vanino and S. Rohlfis. In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 281-288 5 refs. Bundesministerium der Verteidigung Contract No TR-720-7600-43-094, Bundesministerium für Forschung und Technologie Contract No. LFF-28.

Two different versions of a supercritical wing for fighter aircraft were designed. Both are the same in the outer part of the wing but differ in the inner part as well as in section geometry and planform. A relaxation method for the inviscid transonic flow around wing-body combinations was used to carry out the aerodynamic design of the wing starting with initial conditions from the equivalent airfoil section flow. Viscous effects are taken into account by calculating the displacement thickness of the quasi three-dimensional boundary layer. The experimental wing will be mounted to the fuselage of the Alpha Jet. B J

**A76-27857** An experimental investigation of Garabedian and Korn's shockless lifting aerofoil No. 1 N Pollock and B D Fairlie (Department of Supply, Aeronautical Research Laboratories, Melbourne, Australia) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 289-296 8 refs

Transonic wind tunnel tests have been carried out on a shockless lifting aerofoil designed by the method of Bauer, Garabedian and Korn. Two models of different chord lengths were tested to provide some information on tunnel wall interference. Close to the design point the analysis method of Garabedian and Korn agrees well with the experimental measurements. Optical flow visualization results indicate that the design point flow is, for practical purposes, shock free and measured pressure distributions provide further experimental verification of the design method (Author)

**A76-27860** An exact hodograph method for the design of supercritical wing sections A Eberle (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 314-321

This contribution describes a simple hodograph method for the design of transonic airfoils mainly based on Sobieczky's rheograph transformation. A classical panel method solves the elliptic part of the flow problem, whereas a method of characteristics is applied for the treatment of the imbedded supersonic region. (Author)

**A76-27863** Mathematical method of designing a certain compressor type plane blade cascade M Ruzicka (Statní Vyzkumný Ústav Konstrukce Strojů, Bechovice, Czechoslovakia) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 340-349

The paper presents the method enabling the solution of so called indirect theory problem of blade cascades in case when the flowing medium is an ideal gas, inlet Mach number is supersonic and outlet Mach number subsonic. The supersonic part of the blade cascade is designed by the method of characteristics and the subsonic part by the hodograph method (Author)

**A76-27864** Transonic aerodynamics and the helicopter rotor. P G Wilby and J Grant (Royal Aircraft Establishment, Farnborough, Hants, England) In Symposium Transsonicum II, Göttingen, West Germany, September 8-13, 1975, Proceedings

Berlin, Springer-Verlag, 1976, p 350-361 24 refs.

It is pointed out that advances in the area of transonic aerodynamics are leading to a revolution in helicopter rotor design. Aerodynamic limitations to rotor performance are considered along with blade section design aims, the interaction between rotor performance and geometry, and advancing blade tip aerodynamics. It is shown that transonic aerodynamics plays an important part in determining the characteristic of a helicopter rotor and that a full understanding of the transonic aerodynamic problems is required before a fully optimized design is possible. G R

**A76-27865** A review of numerical techniques for calculating supercritical airfoil flows. M Holt (California, University, Berkeley, Calif.) In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 362-368 12 refs

Three numerical methods for calculating transonic supercritical flow past airfoils are reviewed. The first is the complex characteristics approach of Garabedian, the second is the method of integral relations developed mostly by Tai, and the third is a development of Telenin's method initiated by Chattot in application to the double wedge problem. (Author)

**A76-27869** Review of some numerical solutions of the transonic small disturbance equations. E M Murman (Flow Research, Inc., Kent, Wash.) In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 415-422 7 refs

The review takes into account solutions which have been computed during the past five years. Approaches which use difference equations to solve the nonlinear transonic small disturbance equation are considered. The difference equations may be solved by a number of relaxation algorithms and at least two semidirect procedures. The solution of a supercritical flow past a parabolic arc airfoil in a subsonic stream is discussed and attention is given to detached bow wave solutions for supersonic freestream Mach numbers. G R

**A76-27874** Research in the UK on finite difference methods for computing steady transonic flows. R C Lock (Royal Aircraft Establishment, Farnborough, Hants, England). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 457-486. 28 refs

The transonic small perturbation equation for inviscid two-dimensional flow over lifting airfoils is solved using a new RAE finite difference method essentially the same as that proposed by Murman and Cole (1970). The method is applied to the analysis of flow over the NACA 64A410, RAE 9550 and BGK II airfoils. The two-dimensional finite difference method developed by Fruman and Jones (1975) is described as is the two-dimensional Garabedian method (1973). Finite difference methods are proposed for the analysis of three-dimensional wings, including the direct calculation method and the wing design method. B.J

**A76-27875** Some numerical results of a new three-dimensional transonic flow method. Y C-J Sedin and K R Karlsson (Saab-Scania AB, Linköping, Sweden). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 487-494. 6 refs. Research supported by the Styrelsen for Teknisk Utveckling.

A study is made to extend a certain axisymmetric transonic flow method to apply to three-dimensional flow around wing-body combinations. The small perturbation potential is decomposed into two new functions forming a coupled system. Separately, these equations may be regarded as two 'parabolic' equations. The

directions of integration are laterally outwards and inwards. The equations are solved iteratively in a reciprocating manner between the considered configuration and a chosen outer boundary. The rate of convergence is high and the obtained results are consistent with other methods. Both lifting and nonlifting cases are treated. (Author)

**A76-27877** Supercritical flow past airfoils at Mach numbers close to one. D Euvrard (Ecole Nationale Supérieure de Techniques Avancées, Paris, France) and Y Morchoisne (Société Nationales Industrielle Aérospatiale, Suresnes, Hauts-de-Seine, France). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 507-514. 8 refs. Direction des Recherches et Moyens d'Essais Contract No 73/030

A direct method already presented by Euvrard and Tournemine (1973) but including some recent improvements is used to compute the sonic flow over a given symmetrical airfoil. It is a shooting method, each iteration of which consists in integrating a mixed elliptic-hyperbolic system of nonlinear equations with initial and boundary data. This is achieved with a finite difference scheme involving an adequate artificial viscosity. The flow is then continued downstream of the transonic boundary using the method of characteristics. A number of comparisons are made with experimental data and with supercritical computations using relaxation methods. This clearly demonstrates the reality of the well-known 'freezing phenomenon'. The empirical rule from Sinnott and Osborne is also applied and discussed. (Author)

**A76-27878** A direct method for computing non-symmetrical plane flows at Mach number one. F Grosjean and G. Tournemine (Brest, Université, Brest, France). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 515-522. 7 refs. Direction des Recherches et Moyens d'Essais Contract No 73/030

A numerical method adapted to the computation of sonic or nearly sonic flows is applied to a non-symmetrical two-dimensional flow. The mixed elliptic-hyperbolic system of nonlinear flow equations is integrated using a finite difference scheme involving some numerical viscosity. The method is used to calculate the transonic flow past the NACA 0012 airfoil. B J

**A76-27879** The analysis of arbitrary wingbody combinations in transonic flow using a relaxation method. W. Schmidt and R. Vanino (Dornier GmbH, Friedrichshafen, West Germany). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p. 523-532. 12 refs. Bundesministerium der Verteidigung Contract No TR-720-R-7600-42-009

The Dornier relaxation method (1974) for the numerical simulation of various wing-body configurations is described. The method solves the transonic perturbation potential equation in a rectangular grid box with variable mesh size, taking account of the elliptic-hyperbolic nature of the equation by central and backward differences for the streamwise derivatives. The method is applied to different wing-body combinations: to a 30 degree swept wing with biconvex section mounted on a circular body, on a rectangular body, and on a cylindrical body. B.J.

**A76-27880** Numerical solutions for transonic flows past wing-body combinations. C M Albane, M G Hall, and G Joyce (Royal Aircraft Establishment, Farnborough, Hants, England). In Symposium Transsonicum II, Gottingen, West Germany, September 8-13, 1975, Proceedings. Berlin, Springer-Verlag, 1976, p 541-548. 5 refs

A numerical method has been developed for calculating the inviscid flow past lifting wing-body combinations by solving a form of the transonic small-perturbation equation for the velocity potential. An outline is given of the formulation of the problem and the procedure for numerical solution. Numerical results are com-

pared with data from wind-tunnel tests on a wing-body configuration, and the variation of body interference with angle of incidence and free-stream Mach number is illustrated (Author)

**A76-27930 #** Improvement of the precision of aircraft control during completion of a plane turn maneuver (Povyshenie tochnosti upravleniya letatel'nykh apparatami pri sovershenii manevra ploskii razvorot) E Ia Sirotkin and A F Taratin (Leningradskii Institut Aviatsonnogo Priborostroeniia, Leningrad, USSR) *Pribo-rostroenie*, vol 19, no 1, 1976, p 48-53 In Russian

The error in reproduction of a programmed trajectory of a plane turn due to the time lag of the aircraft is analyzed Numerical modeling shows that this error can be greatly reduced by advancing the time that the turn command is given by an interval determined from the parameters of the aircraft-autopilot system A numerical example is given C K D

**A76-28029 \* #** Preparation of eutectic superalloys by EFG G F Hurley and N W Marr (Mobil Tyco Solar Energy Corp, Waltham, Mass) *American Institute of Mining, Metallurgical, and Petroleum Engineers, International Conference on In Situ Composites, 2nd, Lake George, N Y, Sept 2-5, 1975, Paper 10* p 5 refs Contracts No NAS3-16790, No NAS3-18909

An attempt was made to produce airfoil shaped bars of three different eutectic superalloys by means of the edge-defined, film-fed growth (EFG) method The alloys used were a gamma + delta Ni-Cb alloy, a gamma/gamma prime + delta Ni-Cb-Al alloy and a Co-TaC alloy containing Ni and Cr The development of a new die material was essential in the investigation since these alloys are reactive toward known die materials Tantalum carbide was selected as a die material because it exhibited spontaneous capillary rise and slow rate of degradation in the liquid metals Eutectic bars up to 1 mm thick and 6 mm wide were grown from TaC dies in order to determine the growth characteristics and the thermal gradient Large bars of the gamma/gamma prime + delta alloy were grown and tensile tested A die with a blind central cavity was designed and several hollow, tear-shaped bars were grown B J

**A76-28033 #** Fundamental formulation of airship performance and flight dynamics A Azuma (Tokyo, University, Tokyo, Japan) *Tokyo University, Institute of Space and Aeronautical Science, Report*, no 536, vol 40, Dec 1975, p 457-489 14 refs

A fundamental analysis of airship performance and flight dynamics is presented From the performance calculations of four airships, it can be concluded that only large airships, the gross weight of which is more than about 500 tons, have good transport efficiency compared with other vehicles in the operational speed range of 50 to 200 km/hr The handling qualities of the airships are, however, very poor for larger sizes because of small control capability against huge virtual mass and moment of inertia of the hull Thus, large airships are very difficult to maneuver at and near hovering flight (Author)

**A76-28100 #** Rocket engines GDL-OKB V P Glushko (Academy of Sciences, Gas Dynamics Laboratory, USSR) Moscow, Agentstvo Pechati Novosti, 1975 70 p Translation

The organization and history of the Gas Dynamics Laboratory (GDL) and the Experimental Design Bureau (OKB) Aircraft liquid-propellant rocket engines of the USSR are outlined The development of chemical and pyrotechnical ignition, swirltype injectors, internal cooling systems, and suitable structural materials for liquid-propellant rocket engines using a nitric acid-kerosene propellant, and the subsequent evolution of the high-boiling-point liquid-propellant rocket engines in the ORM and RLA series, are reviewed The characteristics of the different engines of the RD series, used to launch satellites, unmanned lunar and planetary probes, and the manned Vostok, Voskhod, and Soyuz spacecraft, are discussed C K D

**A76-28254 #** Effect of the upper limit of distribution function of aircraft structure on the main failure's distribution M Samir Abdelsalam *Zprava VZLU*, no Z-26, 1975 7 p 8 refs

An estimation of distribution function of main failures of aircraft structures is carried out It is the case when taking in to consideration the location of the last failure - from the total failures forming the distribution function of the whole structure of an aircraft - as a random variable A practical example is given to show the application of the given method (Author)

**A76-28255 #** Estimation of population reliability function of aircraft structures from a limited fleet of aircraft M Samir Abdelsalam *Zprava VZLU*, no Z-27, 1975 6 p 10 refs

The population reliability function of aircraft structures is determined This is based on the knowledge about the course of failures of individual structures That is to say on the total number of failures, the location of main failures (they are such failures which cause stopping the normal operation of the structure) and the total number of structures under investigation A practical example is given to indicate the procedure (Author)

**A76-28256 #** Aerodynamic derivatives of the longitudinal motion of the whole aircraft (Aerodynamické derivace podélného pohybu celeho letounu) Z Skoda *Zpravodaj VZLU*, no 5, 1975, p 169-176 6 refs In Czech

A new minicomputer-oriented method for calculating the aerodynamic derivatives of steady-state longitudinal motion of an entire aircraft, ignoring compressibility of flow, is presented Direct mathematical formulas for flow around the aircraft as an integral body are employed The method of small perturbations is invoked to simplify the problem and arrive at a system of linear integral equations The resulting system is solvable by approximating a distributed loading of the wings by a system of discrete forces, whose values are computed via a system of linear algebraic equations The method is recommended for evaluating the properties of newly designed aircraft R D V

**A76-28258 #** Extension of slender body theory (Rozsireni teorie stihleho telesa) O E A Hamid *Zpravodaj VZLU*, no 6, 1975, p 231-237 18 refs In Czech

The extension of slender body theory considered consists in retaining certain terms which were neglected during the derivation of the equations of the original theory The extended theory takes into account the effect of body shape and Mach number on the outcome of the solutions and refines the calculation of aerodynamic coefficients Applications of the extended theory are illustrated on the examples of a slender body oscillating in the flow of an incompressible fluid and of a flat delta wing in steady supersonic flow P T H

**A76-28259 #** Effect of gusts on helicopter loading (Vliv poryvu na zatizeni vrtulniku) M Kucera *Zpravodaj VZLU*, no 6, 1975, p 239-252 In Czech

A method is proposed for aiding in the determination of the fatigue properties of helicopter designs by which the interpretation of the design loading can be made to approximate the level of the load spectra of fixed-wing aircraft In an experiment, the load factor spectrum was determined for a helicopter and the escort aircraft L-40 as well as the spectrum of stresses on the rotor blade and the rotor control level during flight through an isolated gust Because of the large range of flight speeds and helicopter specifications, a significant influence on loading is exerted by the gust alleviating factor, to obtain which is more difficult in the case of a helicopter than that of an airplane The results show that this method for determining helicopter gust spectra is acceptable and the gust stress spectra are significant for the rotor blade P T H

**A76-28354 #** Hydraulic systems for transport aircraft (Gidravlicheskie sistemy transportnykh samoletov) Zh S Chernenko, G S Lagosiuk, G N Nikulinski, and B Ia Shvets Moscow, Izdatel'stvo Transport, 1975 184 p 11 refs In Russian

The book gives an exposition of the chief requirements imposed on large aircraft hydraulic systems, describes the operational characteristics of working fluids, and illustrates aircraft hydraulic systems with functional diagrams and cross-sectional diagrams of the chief components. Factors influencing the reliability of tubing and seals are studied, and recommendations are given regarding the servicing and exploitation of linking equipment and sealing devices. The reliability characteristics of hydraulic systems are investigated, with analyses taking into account flight regimes and exploitation factors on reliability. P T H

**A76-28469** Limitations of the flight regime of a supersonic transport /SST/ by the sonic boom (Die Beschränkung des Flugbereichs eines Überschallverkehrsflugzeugs /SST/ durch den Schallknall) M Kloster (München, Technische Universität, Munich, West Germany) *Zeitschrift für Flugwissenschaften*, vol 24, Mar-Apr 1976, p 82-89 31 refs In German

The characteristics of the height-Mach number diagram for an SST on the basis of data for an early design stage of the Concorde are considered and a description of flight performance calculations is given, taking into account an operation with and without afterburner. The limitations of the flight regime in the case of supersonic aircraft are indicated in a graph. An investigation is conducted concerning the effect of the sonic pressure and the influence of this parameter on the flight regime. It is found that considerations related to the sonic pressure reduce the range for the operational-parameter values. Attention is given to design changes for optimizing aircraft performance under the constraint of the given regulations regarding the permissible sonic pressure. G R

**A76-28542** # Results of noise and vibration studies on An-24 aircraft (Wyniki badan hasasu i drgan samolotow An-24) C Puzyna (Centralny Instytut Ochrony Pracy, Warsaw, Poland) In *Ergonomics in aviation*, National Scientific-Technological Conference, 1st, Warsaw, Poland, March 17-19, 1975, Proceedings. Warsaw, Instytut Lotnictwa, 1975, p 171-178 In Polish

Basic findings from a program of tests on the noise and vibration levels in selected areas of the An-24 aircraft in various flight phases and on the runway are discussed. This aircraft has two under-the-wing turboprop engines, each of rated power 2100 hp. The engines are located about 2.5 meters from the passenger cabin walls. It was determined in particular that the noise level in the crew cabin exceeds accepted norms. Some measures are proposed to ensure that the crew is not overloaded as a result of noise. P T H

**A76-28543** # Ergonomics and the problem of aircraft-induced external noise (Ergonomia i problem hasasow zewnetrznych wywoływanych przez samolot) T Rappert (Zarząd Lotniskowy, Warsaw, Poland). In *Ergonomics in aviation*, National Scientific-Technological Conference, 1st, Warsaw, Poland, March 17-19, 1975, Proceedings. Warsaw, Instytut Lotnictwa, 1975, p 179-188 In Polish.

Some ergonomic problems are discussed, with particular reference to the aviation aspects of man/machine interaction. The characteristics of internal and external aircraft noise are studied, along with the effects of internal noise on the passenger and crew environments. Particular attention is given to the effect of external aircraft noise on the working conditions and performance of airport personnel and to the noise abatement problem. V P.

**A76-28544** # Ergonomic analysis of maneuvers leading to inaudibility of a shock wave (Ergonomiczna analiza manewrow prowadzących do niesłyszalności fali uderzeniowej) R Makarewicz (Poznań, Uniwersytet, Poznań, Poland) In *Ergonomics in aviation*, National Scientific-Technological Conference, 1st, Warsaw, Poland, March 17-19, 1975, Proceedings. Warsaw, Instytut Lotnictwa, 1975, p 189-195 In Polish.

An analysis of supersonic flight with shock wave is presented in order to determine those combinations of flight parameters under

which the load factor attains a certain critical value for a critical length of time, ensuring that the shock wave is inaudible on the ground. Numerical values for the load factor and the time interval are obtained, which can serve as a basis for determining the optimal aircraft maneuver ensuring inaudibility of the shock wave, where optimality is understood in the sense of shortest time spent at the critical load factor for the minimal load factor value. P T H

**A76-28545** # Selected problems of cockpit acoustic design (Wybrane zagadnienia akustycznego projektowania kabin) A Rudiuk (Instytut Lotnictwa, Warsaw, Poland) In *Ergonomics in aviation*, National Scientific-Technological Conference, 1st, Warsaw, Poland, March 17-19, 1975, Proceedings. Warsaw, Instytut Lotnictwa, 1975, p 196-212 In Polish.

Cockpit noise is broken down into external noise penetrating into the cockpit through the walls and glass surfaces, noise multiply reflected from internal surfaces of the cockpit, noise generated in the cockpit itself, and noise generated by vibrations of the cockpit's mechanical elements. The noise-absorbing and noise-damping properties of materials used to construct the cockpit walls are reviewed. The influence of discontinuities (such as doors, windows, etc.) on the insulating properties of aircraft walls is examined. V P.

**A76-28606** \* # Subsonic loads on wings having sharp leading edges and tips O A Kandil, D T Mook, and A H Nayfeh (Virginia Polytechnic Institute and State University, Blacksburg, Va.) *Journal of Aircraft*, vol 13, Jan 1976, p 62, 63 10 refs Grant No NGR-74-004-090

A vortex-lattice method for predicting the aerodynamics of wings having separation at the sharp edges in incompressible flows is extended to compressible subsonic flows using a modified Prandtl-Glauert transformation. Numerical results showing the effect of freestream Mach number on the aerodynamic coefficients are compared with available experimental data for several planforms. It is shown that the proposed method is suitable for predicting the aerodynamic loads on low-aspect wings at moderate angles of attack for high subsonic freestream Mach number. The method is limited to angles of attack up to 12 deg for high subsonic freestream Mach number and to angles of attack up to 20 deg for Mach number not exceeding 0.5. S D.

**A76-28607** # Use of fracture mechanics in estimating structural life and inspection intervals M P Kaplan and J A Reiman (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) *Journal of Aircraft*, vol 13, Feb 1976, p 99-103 20 refs.

As structural efficiency of aircraft has increased in the recent past, the Air Force has found it necessary to include, in the newer systems, damage tolerance criteria for fracture critical parts. These criteria are explained briefly, and sample calculations indicating methods for determining component structural life are demonstrated. Implicit in this calculation is the definition of inspection intervals. The second portion of this discussion details some of the assumptions that go into this analysis and their sensitivity. A large portion centers on stress spectrum definition. It is shown that, from one set of occurrence data, alternative spectra may be derived which have substantial differences in life. (Author)

**A76-28608** # Nozzle afterbody configuration development for the B-1 strategic bomber J C Sargent and J L Gunter (Rockwell International Corp., Los Angeles, Calif.) (*American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 10th, San Diego, Calif., Oct 21-23, 1974, AIAA Paper 74-1102*) *Journal of Aircraft*, vol 13, Feb 1976, p 135-139.

An experimental evaluation was conducted on several aft nacelle/nozzle configurations. The wind-tunnel data are presented for different nozzle shapes, variations of the nacelle fineness ratio, and different internozzle fairing configurations. These results were used in mission studies to define the aircraft configuration. A relatively short, light-weight nozzle was integrated with the nacelle to provide better mission performance than a longer, heavier design. Increasing

the nacelle fineness ratio by increasing the length reduced drag, but this was offset by the increased weight. A fixed internozzle fairing incorporating the precooler air discharge from the ECS was selected over other concepts (Author)

**A76-28610 # Representation of the drag polar of a fighter aircraft.** K S Yajnik and M V Subbaiah (National Aeronautical Laboratory, Bangalore, India) *Journal of Aircraft*, vol 13, Feb 1976, p 155, 156

A simple additive correction to the classical representation of the drag coefficient which is insignificant when the square of the lift coefficient is small has been derived. The resulting simplified representation can be described as a quadratic curve of regression of the drag coefficient on the square of the lift coefficient. Using data on the drag polars of YF-16, it is shown that the proposed approximation can be used in turn calculations for a fighter aircraft.

C K D

**A76-28611 # Analysis of circulation controlled airfoils.** E H Gibbs and N Ness (West Virginia University, Morgantown, W Va) *Journal of Aircraft*, vol 13, Feb 1976, p 158-160. 12 refs. Contract N00014-68-A-0512

A self contained analysis for circulation controlled airfoils of arbitrary shape in incompressible flow is presented. The potential flow is analyzed by the Theodorsen method (1933). Boundary-layer analyses are carried out for the upper and lower surfaces of the aircraft using the Cebeci-Smith finite-difference method (1969). The analysis of the turbulent wall jet region begins at the blowing slot and proceeds downstream until separation occurs. The Thwaites condition is satisfied by an iteration on a slot blowing momentum coefficient. The theoretical model gives reasonable agreement with limited test data.

C K D

**A76-28642 Note on a numerical scheme for the three-dimensional flow of a supercavitating wing or strut with thin cavity.** B Yim (U S Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md) In *Cavitation and polyphase flow forum - 1976, Proceedings of the Joint Meeting, New Orleans, La, March 21-25, 1976*. Meeting sponsored by the American Society of Mechanical Engineers. New York, American Society of Mechanical Engineers, 1976, p 35, 36. 5 refs.

A supercavitating wing with a given load distribution is treated numerically in a manner similar to that used in airfoil theory. The design problem for a given load distribution on the supercavitating airfoil is reduced to the solution of a Fredholm integral equation of the first kind for the cavity source strength, as in the problem of determining the vortex distribution in the thin airfoil problem. The specific features of the numerical scheme are demonstrated, and some results of numerical experiments are discussed.

V P

**A76-28693 Helicopter rotor blades - The new technology.** R Mouille (Societe Nationale Industrielle Aérospatiale, Paris, France) *Shell Aviation News*, no 433, 1976, p 20-25.

The use of reinforced plastics in the fabrication of helicopter rotor blades offers significant advantages over metal materials. In addition to relatively high fatigue strength to density ratios and lack of sensitivity to notch effect and fatigue-corrosion phenomena, it is possible to vary the plan form, relative thickness and airfoil camber of the plastic blade, as well as its torsional rigidity characteristics. Maintenance costs are minimized by the long life-time and ease of repair of plastic blades. The effect of a switch to all plastic rotor blades on the performance of the Puma is discussed. A 13 per cent reduction in the cost per kg/km is predicted as the result of decreased maintenance costs and fuel consumption and increased payload.

C K D

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## STAR ENTRIES

**N76-20063\*#** Hudson Inst Inc Croton-on-Hudson NY  
**THE OUTLOOK FOR AERONAUTICS, 1980 - 2000 - STUDY REPORT**

Mar 1976 41 p  
 (Contract NAS5-20852)  
 (NASA-TM-X-72995) Avail NTIS HC \$4 00 CSCL 01B

Trends in civil and military aviation in the period 1980-2000 are examined in terms of the role that NASA should play in aeronautical research and development during this period. Factors considered include the pattern of industry and government relationships, the character of the aircraft to be developed, and the technology advances that will be required as well as demographic, economic, and social factors. Trends are expressed in terms of the most probable developments in civil air transportation and air defense and several characteristically different directions for future development are defined. The longer term opportunities created by developments in air transportation extending into the next century are also examined. Within this framework, a preferred NASA role and a preferred set of objectives are formulated for the research and technology which should be undertaken by NASA during the period 1976-1985. Author

**N76-20064\*#** Hudson Inst Inc Croton-on-Hudson NY  
**THE OUTLOOK FOR AERONAUTICS, 1980 - 2000**  
**APPENDIX B STUDY GROUP REPORT ON AN INDUSTRY-UNIVERSITY-GOVERNMENT SURVEY**

Mar 1976 46 p  
 (Contract NAS5-20852)  
 (NASA-TM-X-72996) Avail NTIS HC \$4 00 CSCL 01B

Results of a comprehensive survey of key representatives of the aeronautical community are presented. Emphasis is placed on trends in civil and military aviation, the role of NASA in aeronautical research and development, and the required technology advances for the development of new aircraft. JMS

**N76-20065\*#** Hudson Inst Inc Croton-on-Hudson NY  
**DOMESTIC AND WORLD TRENDS AFFECTING THE FUTURE OF AVIATION (1980 - 2000), APPENDIX C**

Mar 1976 78 p  
 (Contract NAS5-20852)  
 (NASA-TM-X-72997) Avail NTIS HC \$5 00 CSCL 01B

The results are presented of a study of variables affecting aviation in the United States during the last fifth of the twentieth century. A series of key trends relating to economic, social, political, technological, ecological, and environmental developments are identified and discussed with relation to their possible effects on aviation. From this analysis a series of scenarios is developed representing an array of possibilities ranging from severe economic depression and high international tension on the one hand to a world of detente which enjoys an unprecedented economic growth rate and relaxation of tensions on the other. A scenario is presented which represents the manner in which events will most probably develop and their effect on the aviation industry. Author

**N76-20066\*#** Hudson Inst Inc Croton-on-Hudson NY  
**THE OUTLOOK FOR AERONAUTICS, 1980 - 2000**  
**EXECUTIVE SUMMARY**

Mar 1976 18 p  
 (Contract NAS5-20852)  
 (NASA-TM-X-72998) Avail NTIS HC \$3 50 CSCL 01B

Trends in civil and military aviation in the period 1980-2000 are examined in terms of the role that NASA should play in aeronautical research and development during this period. Factors considered include the pattern of industry and government relationships, the character of the aircraft to be developed, and the technology advances that will be required as well as demographic, economic, and social factors. Trends are expressed in terms of the most probable developments in civil air transportation and air defense and several characteristically different directions for future development are defined. The longer term opportunities created by developments in air transportation extending into the next century are also examined. Within this framework, a preferred NASA role and a preferred set of objectives are formulated for the research and technology which should be undertaken by NASA during the period 1976-1985. Author

**N76-20067#** Advisory Group for Aerospace Research and Development Paris (France)

**AGARD HIGHLIGHTS, MARCH 1976**

1 Mar 1976 33 p  
 (AGARD-Highlights-76/1) Avail NTIS HC \$4 00

Reports of AGARD activities are presented. The articles presented concern hurricane Eloise, Von Karman medals for 1975, air traffic control, aircraft fire safety, and personnel changes.

FOS

**N76-20068#** Federal Aviation Administration Washington D C  
 Aviation Forecast Branch

**MILITARY AVIATION FORECASTS, FISCAL YEARS 1976 - 1987**

Sep 1975 38 p refs  
 (AD-A017622 FAA-AVP-75-12) Avail NTIS HC \$4 00 CSCL 01/2

Forecasts of military air traffic activity at facilities operated by the Federal Aviation Administration for the fiscal years 1976 through 1987 are presented. Data are given for all branches of the military and cover flight for the continental United States.

Author

**N76-20069#** Federal Aviation Administration Washington D C  
 Aviation Forecast Branch

**AVIATION FORECAST, FISCAL YEARS 1976 - 1987**

Sep 1975 76 p  
 (AD-A017095 FAA-AVP-75-7) Avail NTIS HC \$5 00 CSCL 01/2

The latest Federal Aviation Administration forecast of measures of workload and activity at towered airports, air route traffic control centers, and flight service stations for Fiscal Years 1976 to 1987 are given. The forecasts were made for the four major users of the system: air carriers, air taxi, general aviation, and the military. The impact is reflected on aviation activity of a more rapid rate of price increase, especially for fuel, and a slower rate of real income growth than had been assumed in previous forecasts.

Author

**N76-20070#** Deutsche Gesellschaft fuer Luft- und Raumfahrt  
 Cologne (West Germany)

**HISTORY OF MESSERSCHMITT AIRCRAFT MANUFACTURING**

Johann Baptist Kaiser 29 Oct 1975 43 p refs In GERMAN  
 ENGLISH summary  
 (DLR-Mitt-75-21) Avail NTIS HC \$4 00 DFVLR Cologne DM 22 20

The career of Willy Messerschmitt and the history of his firm is presented. Messerschmitt constructor and research worker, aircraft builder and industrialist, is one of the last living pioneers from the start of the development of aeronautical technology at the beginning of this century. His contribution to this development is described.

ESA

**N76-20071#** Federal Aviation Administration Washington D C  
Office of Management Systems  
**THE 1974 US CIVIL AIRMEN STATISTICS Annual Study**  
May 1975 36 p  
(AD-A013434) Avail NTIS CSCL 05/9

The 1974 US Civil Airmen Statistics is the sixth edition of an annual study published to meet the demands of FAA other government agencies and industry for more detailed airmen statistics than those published in other FAA reports Statistics pertaining to airmen both pilot and nonpilot were obtained from the official airman certification records maintained by the Flight Services Technical Division FAA Aeronautical Center Oklahoma City Oklahoma GRA

**N76-20072#** Federal Aviation Administration Washington D C  
Office of Aviation Policy  
**THE GENERAL AVIATION INDUSTRY, AN OVERVIEW Staff Study Report**

Thomas F Henry and Maryann Froehlich Jul 1975 66 p refs

(AD-A015871 FAA-AVP-75-4) Avail NTIS CSCL 01/3

This report presents background information and statistics on various aspects of the general aviation (GA) industry The report documents the impressive growth of the general aviation fleet particularly since the 1960's and illustrates recent trends in GA aircraft types and user categories It emphasizes that GA activities are becoming increasingly important in the National Aviation System of Airports and Airways and that this implies increased FAA workload The report also discusses trends in aircraft production and export and the relative market shares of the producers of GA aircraft as well as the industry's overall contribution to the US balance of payments The discussion of energy considerations suggests that the Arab oil embargo and subsequent increases in oil prices brought on by the pricing policies of the Organization of Petroleum Exporting Countries (OPEC) had minimal effects on GA activities However legislative proposals designed to impose substantial taxes on gasoline production or sale might have depressing effects on future GA activities Author (GRA)

**N76-20073** California Inst of Tech Pasadena  
**EXPERIMENTS ON THIN AIRFOILS SPANNING A TRANSONIC SHEAR FLOW Ph D Thesis**  
Raymond Robert Cosner 1976 346 p  
Avail Univ Microfilms Order No 76-6525

A wind tunnel was built at the California Institute of Technology to provide two uniform coflowing streams at Mach numbers of 0.6 and 1.4 with a plane mixing layer in between Preliminary studies were made of this free shear layer indicating a region of self-similar behavior and general agreement in growth rate with previous studies A program of experimental and theoretical work was completed in which wedges were installed in the supersonic stream to create shock waves incident on the

**N76-20077\*#** Boston Univ Mass  
**FULLY UNSTEADY SUBSONIC AND SUPERSONIC POTENTIAL AERODYNAMICS FOR COMPLEX AIRCRAFT CONFIGURATIONS FOR FLUTTER APPLICATIONS**  
Kadin Tseng and Luigi Morino [1975] 14 p refs Presented at AIAA/ASME/SAE 17th Structures Structural Dynamics and Materials Conf  
(Contract NGR-22-004-030)  
(NASA-CR-146573) Avail NTIS HC \$3.50 CSCL 01A

A general theory for study oscillatory or fully unsteady potential compressible aerodynamics around complex configurations is presented Using the finite-element method to discretize the space problem one obtains a set of differential-delay equations in time relating the potential to its normal derivative which is expressed in terms of the generalized coordinates of the structure For oscillatory flow the motion consists of sinusoidal oscillations around a steady subsonic or supersonic flow For fully unsteady flow the motion is assumed to consist of constant subsonic or supersonic speed for time  $t < 0$  and of small perturbations around the steady state for time  $t > 0$  Author

**N76-20078\*#** Scientific Translation Service Santa Barbara Calif  
**AIRCRAFT USE IN AGRICULTURE AND FORESTRY**  
V A Nazarov Washington Feb 1976 420 p Transl into ENGLISH of the book *Primeneniye Aviatsii v Selskom - Lesnom Khozyaystve* Moscow Transport 1975 p 1-311  
(Contract NASw-2791)

(NASA-TT-F-16846) Avail NTIS HC \$11.00 CSCL 01C

Information is presented (a textbook) on the use of aircraft in agriculture and forestry agricultural equipment for airplanes and helicopters and the technology for performing organizing and standardizing aircraft application operations All forms of aerial agricultural chemical application operations are covered in detail with consideration for the latest data (1) combatting plant pests and diseases (2) weed suppression (3) mineral fertilizer application (4) crop defoliation (5) desiccation and so on The latest experience in crew operational procedures and the latest scientific advances are examined Photographs are included

Author

**N76-20079\*#** National Aeronautics and Space Administration  
Ames Research Center Moffett Field Calif  
**EXPERIMENTAL AERODYNAMIC CHARACTERISTICS FOR SLENDER BODIES WITH THIN WINGS AND TAIL AT ANGLES OF ATTACK FROM 0 DEG TO 58 DEG AND MACH NUMBERS FROM 0.6 TO 2.0**

Leland H Jorgensen and Edgar R Nelson Washington Mar 1976 159 p refs

(NASA-TM-X-3310 A-6248) Avail NTIS HC \$6.75 CSCL 01A

An experimental investigation was conducted by wind tunnel to measure the static aerodynamic characteristics for bodies of circular and elliptic cross section with various thin flat plate wings and a thin tail consisting of horizontal and vertical parts The wings had aspect ratios of 4 and taper ratios of about 0.25 and 0.5 Two additional wings which had taper ratios near 0.25 and aspect ratios of about 3 and 5 were also tested in combination with the bodies and tail All wings had about the same planform area The exposed area of the horizontal portion of the tail was about 33 to 36 percent of the exposed area of the wings The exposed area of the vertical tail fin was about 22 to 24 percent of the exposed area of the wings The elliptic body with an  $a/b = 2$  cross section had the same length and axial distribution of cross sectional area as the circular body The circular body had a cylindrical aftersection of fineness ratio 7 and it was tested with the wings and tail in combination with tangent ogive noses that had fineness ratios of 2.5, 3.0, 3.5 and 5.0 In addition an ogive nose with a rounded tip and an ogive nose with two different nose strake arrangements were used Nineteen configuration combinations were tested at Mach numbers of 0.6, 0.9, 1.5 and 2.0 at angles of attack from 0 to 58 deg The Reynolds numbers based on body base diameter were about  $4.3 \times 10^6$  Author

**N76-20081\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station, Va  
**PRESSURE DISTRIBUTIONS ON A RECTANGULAR ASPECT-RATIO-6, SLOTTED SUPERCRITICAL AIRFOIL WING WITH EXTERNALLY BLOWN FLAPS**  
William G Johnson Jr Washington Apr 1976 254 p refs  
(NASA-TM-X-3337 L-10558) Avail NTIS HC \$9.00 CSCL 01A

An investigation was made in the 5.18 m (17 ft) test section of the Langley 300 MPH 7 by 10 foot tunnel on a rectangular aspect ratio 6 wing which had a slotted supercritical airfoil section and externally blown flaps The 13 percent thick wing was fitted with two high lift flap systems single slotted and double slotted The designations single slotted and double slotted do not include the slot which exists near the trailing edge of the basic slotted supercritical airfoil Tests were made over an angle of attack range of -6 deg to 20 deg and a thrust-coefficient range up to 1.94 for a free-stream dynamic pressure of 526.7 Pa (11.0 lb/sq ft) The results of the investigation are presented as curves and tabulations of the chordwise pressure distributions at the midspan station for the wing and each flap element

Author



**N76-20082\*# Texas A&M Research Foundation College Station  
TRANSONIC AIRFOIL DESIGN USING CARTESIAN  
COORDINATES Final Report**

Leland A Carlson Washington NASA Apr 1976 35 p refs  
(Grant NGR-44-001-157)

(NASA-CR-2578) Avail NTIS HC \$4 00 CSDL 01A

A numerical technique for designing transonic airfoils having a prescribed pressure distribution (the inverse problem) is presented. The method employs the basic features of Jameson's iterative solution for the full potential equation except that inverse boundary conditions and Cartesian coordinates are used. The method is a direct-inverse approach that controls trailing-edge closure. Examples show the application of the method to design aft-cambered and other airfoils specifically for transonic flight.

Author

**N76-20083# Deutsche Forschungs- und Versuchsanstalt fuer  
Luft- und Raumfahrt Goettingen (West Germany) Abteilung  
Angewandter Mathematik und Mechanik**

**VISUALIZATION OF THE SUBSONIC FLOW AROUND TWO  
SPACE GLIDER CONFIGURATIONS**

Hans Bippes and Pavle Colak-Antic 16 Jul 1975 61 p refs  
In GERMAN ENGLISH summary. Original contains color illustrations. Report will also be announced as translation  
(DLR-FB-75-49) Avail NTIS HC \$4 50, DFVLR Cologne  
DM 79 90

The subsonic flow around two delta wing space glider configurations with rounded leading edges and fuselage was made visible in a water towing basin by means of the hydrogen bubble technique for different angles of attack and yaw with Re-numbers ranging from 0.03 million to 1.2 million. Special attention was devoted to the observation of the development of the leading edge and body vortices and their interaction on the stabilizer flow to leading edge vortex burst and to flow separation and turbulence generation. The relevant three-dimensional flow phenomena were recorded by stereo photographs and are reproduced in print as anaglyphs (double-color pictures).

Author (ESA)

**N76-20087# European Space Agency Paris (France)**

**A METHOD FOR THE CALCULATION OF THE TWIST AND  
CAMBER OF A WING WITH A SPECIFIED LOAD DISTRIBUTION  
IN THE PRESENCE OF A FUSELAGE**

Horst Koerner Dec 1975 76 p refs. Transl into ENGLISH of Ein Verfahren zur Berechnung der Verwindung u Verwoelbung des Fluegels bei vorgegebener Lastverteilung unter Beruecksichtigung des Rumpfes. DFVLR Brunswick Report DLR-FB-75-12 1975. Original German report available from DFVLR Porz West Ger DM 30 70.

(ESA-TT-214 DLR-FB-75-12) Avail NTIS HC \$5 00

A theoretical potential flow method is described which can also be applied to wing-fuselage combinations providing the fuselage is of circular cross-section or has approximately this form. The method is derived for incompressible flow but by using the Goethert transformation it may also be used for compressible subsonic flow. The theory, several sample calculations, the program, and its input requirements are described.

Author (ESA)

**N76-20091# Air Force Aero Propulsion Lab Wright-Patterson  
AFB Ohio**

**AN ANALYSIS OF HEAT TRANSFER ON A JOUKOWSKI  
AIRFOIL WITH SEPARATION AND REATTACHMENT**

Interim Report, 1 Jan 1973 - 1 Mar 1975  
Lucien Louis DeBruege Jul 1975 121 p refs  
(AF Proj 3066)

(AD-A016457 AFAPL-TR-75-28) Avail NTIS CSDL 20/4

The problem of separation bubbles in subsonic flow has been the object of much attention because of its incidence on the performance of turbomachinery and airfoils in general. An analytical method depicting a two-dimensional incompressible steady-state flow over the convex side of a Joukowski airfoil on which a large separation bubble has developed is formulated. This method uses a potential flow configuration in cross flow and two equal but opposite vortices at rest behind the cylinder.

The vortex strength generating the flow recirculation inside the bubble and the perturbation of the inviscid velocity distribution outside the separation bubble are so chosen that the calculated separation in cross flow occurs at a Reynolds number of 100 000. The average heat transfer coefficient obtained is compared with predicted values of flow separation over a cavity. GRA

**N76-20093# Army Aviation Systems Command St Louis Mo  
AIRFOIL PROFILE DRAG Final Report**

Milton A Schwartzberg Jun 1975 39 p refs  
(DA Proj 1F2-62209-AH-76)

(AD-A017321 USAAVSCOM-TR-75-19) Avail NTIS CSDL 20/4

A method is presented for the estimation of the profile drag coefficient of airfoils at subsonic Mach numbers below the drag rise values. The method is applicable to smooth airfoils with fully turbulent boundary layers, at any Reynolds number. The method is simple to apply for rapid estimation purposes and to incorporate into an aircraft performance computation procedure. GRA

**N76-20095# General Motors Corp Indianapolis Ind Detroit  
Diesel Allison Div**

**RESEARCH ON AEROELASTIC PHENOMENA IN AIRFOIL  
CASCADES SUPERSONIC UNSTEADY AERODYNAMIC  
PHENOMENA IN A CONTROLLED OSCILLATING CAS-  
CADE**

Sanford Fleeter Allen S Novick and Ronald E Riffel Oct 1975 78 p refs

(Contract N00014-72-C-0351 NR Proj 094-369)

(AD-A017203 DDA-EDR-8617) Avail NTIS CSDL 20/4

A unique supersonic inlet flow field unsteady cascade experiment is described wherein the time-dependent pressure distribution within a harmonically oscillating airfoil cascade is quantitatively determined. The torsional frequency of oscillation and the interblade phase angle are precisely controlled by means of on-line digital computers. The dynamic data obtained include the chordwise distribution of the unsteady pressure magnitude and its phase lag as referenced to the airfoil motion. Parameters varied include the cascade inlet Mach number, the interblade phase angle, the torsional axis location, and the reduced frequency. All of the data are correlated with state-of-the-art analytical predictions. Author (GRA)

**N76-20096# Purdue Univ Lafayette Ind Project SQUID  
Headquarters**

**UNSTEADY SURFACE FLOW BEHAVIOR ON A CASCADE  
OF AIRFOILS OSCILLATING BELOW STALL Technical  
Report, Mar - Sep 1975**

Franklin O Carta 29 Sep 1975 76 p refs

(Contract N00014-67-A-0226-0005 NR Proj 098-038)

(AD-A017073 SQUID-TR-UTRC-1-PU R75-912083-3) Avail NTIS CSDL 20/4

Tests have been performed on a cascade of airfoils oscillating in pitch using hot films to detect unsteady changes in the flow over the suction surface. It was found that unsteady transition from laminar to turbulent flow propagates forward along the chord and that unsteady reattachment propagates rearward. At low incidence angle the turbulent flow region does not reach the leading edge and at higher incidence angle the laminar flow region does not extend rearward beyond mid chord.

Author (GRA)

**N76-20098# Naval Intelligence Support Center Washington,  
D C Translation Div**

**THE GROUND EFFECT ON THE AERODYNAMIC CHARAC-  
TERISTICS OF AN AIRCRAFT**

Ya M Serebrniskii 23 Oct 1975 55 p refs. Transl into ENGLISH from Uch Zap Tsentr Aerogidrodinamicheskii Inst (USSR) v 267 1936 p 2-37.

(AD-A017309 NISC-Trans-3700) Avail NTIS CSDL 01/1

An analysis of aerodynamic characteristics in steady horizontal flight near the ground is presented. Wieselsberg's formula representing the wing by a vortex sheet is derived and a formula

based on the Helmbold vortex system is proposed. A mirror-image experiment conducted in a TsAGI T-5 wind tunnel with a conventional model wing and a wing with TsAP flaps is described. Results indicate that experimental data agree with theoretical calculations from the formula based on a Helmbold vortex system for a conventional wing. A model of a phenomenon similar to a hydraulic collector system is proposed to explain the phenomena occurring in the wing with flaps. Results of longitudinal stability are also given. Other methods of investigating steady horizontal flight near the ground are briefly reviewed. Author

**N76-20101\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**A STUDY OF THE FINANCIAL HISTORY OF THE US SCHEDULED AIRLINES AND THE IMPROVEMENT OF AIRLINE PROFITABILITY THROUGH TECHNOLOGY**

Darrell E Wilcox Jul 1975 64 p refs  
(NASA-TM-X-73109, A-6462) Avail NTIS HC \$4.50 CSCL 05C

The financial history of the US scheduled airline industry was investigated to determine the causes of the erratic profit performance of the industry and to evaluate potential economic gains from technology advances of recent years. Operational and economic factors affecting past and future profitability of the industry are discussed, although no attempt was made to examine the profitability of individual carriers. The results of the study indicate that the profit erosion of the late 1960s and early 1970s was due more to excess capacity than to inadequate fare levels, but airline problems were severely compounded by the rapid fuel price escalation in 1974 and 1975. Near-term solutions to the airline financial problems depend upon the course of action by the industry and the CAB and the general economic health of the nation. For the longer term, the only acceptable alternative to continued fare increases is a reduction in unit operating costs through technological advance. The next generation of transports is expected to incorporate technologies developed under Government sponsorship in the 1960s and 1970s with significant improvements in fuel consumption and operating costs. Author

**N76-20104\*** Douglas Aircraft Co., Inc., Santa Monica, Calif  
**OPERATIONAL FACTORS OF AIR SERVICE TO SMALL COMMUNITIES Final Report**

Dec 1975 162 p refs  
(Contract NAS2-8135)  
(NASA-CR-137820) Avail NTIS HC \$6.75 CSCL 05A

The feasibility of using 30-passenger jet aircraft to service low density, short haul markets was analyzed. Aircraft characteristics, market potential, and economic factors were among the areas evaluated. DML

**N76-20106\*** National Aeronautics and Space Administration Washington, D C

**GENERAL AVIATION TECHNOLOGY PROGRAM**

Mar 1976 20 p  
(NASA-TM-X-73051, NASA-News-Release-76-51)  
Avail NASA Scientific and Technical Information Facility P O Box 8757 BWI Airport, Md 21240 CSCL 01C

The research and technology program of the civil air transportation system is reported. Research is discussed for stall/spin crashworthiness, pilot operations, flight efficiency, propulsion, and avionics. FOS

**N76-20112#** AeroVironment Inc, Pasadena, Calif  
**INVESTIGATION OF VORTEX WAKE STABILITY NEAR THE GROUND Final Report, 1 Feb 1974 - 31 Mar 1975**

I H Tombach, S C Crow and E R Bate Jr 31 Jul 1975 75 p refs  
(Contract F44620-74-C-0058, AF Proj 9781)  
(AD-A017586, AV-FR-538, AFOSR-75-1501TR) Avail NTIS CSCL 20/4

Vortex wakes exist in a complicated environment near the

ground at airports. Under many situations, factors combine to move a wake sufficiently far from the runway approach corridor that it does not constitute a hazard to following aircraft. Situations exist, however, where a wake can possibly linger at high strength long enough to present operational problems. The sinuous mutual induction instability of a vortex pair has been investigated theoretically and experimentally in atmospheric conditions which prevail near the ground, thereby extending previous work of Crow and Bate for the same instability aloft. Two theoretical models were developed -- one for a vortex pair in the constant stress layer of the atmospheric boundary layer and the second for a vortex interacting with its image when in ground effect. GRA

**N76-20114\*** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**MAGNETIC HEADING REFERENCE Patent**

Howell D Garner, inventor (to NASA) Issued 16 Mar 1976 12 p Filed 11 Dec 1974 Supersedes N75-12947 (13 - 04 p 0382)

(NASA-Case-LAR-11387-1, US-Patent-3 943,763)  
US-Patent-Appl-SN-531647 US-Patent-Class-75-178R,  
US-Patent-Class-33-356) Avail US Patent Office CSCL 17G

A magnetometer is used as a magnetic heading reference for a vehicle such as a small aircraft. The magnetometer is mounted on a directional dial in the aircraft in the vicinity of the pilot such that it is free to turn with the dial about the yaw axis of the aircraft. A circuit is included for generating a signal proportional to the northerly turning error produced in the magnetometer due to the vertical component of the earth's magnetic field. This generated signal is then subtracted from the output of the magnetometer to compensate for the northerly turning error. Official Gazette of the U.S. Patent Office

**N76-20122#** Federal Aviation Administration Washington, D C  
Aviation Forecast Branch

**PROFILES OF SCHEDULED AIR CARRIER OPERATIONS BY STATE LENGTH FEDERAL AVIATION ADMINISTRATION REGIONS TOP 100 US AIRPORTS, 1 NOVEMBER 1974**

May 1975 344 p  
(AD-A016161) Avail NTIS CSCL 01/2

The first section of this report provides data on total scheduled air carrier aircraft operations by trip length by hour of the day for Friday, November 1, 1974, for the top 100 airports within the 50 states of the United States and the District of Columbia. The second section of the report shows the same information for each of the 11 Federal Aviation Administration regions. The FAA regional information is for those airports in the region that are included in the top 100 airports. GRA

**N76-20124\*** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**ENERGY AND ECONOMIC TRADE OFFS FOR ADVANCED TECHNOLOGY SUBSONIC AIRCRAFT**

Dal V Maddalon and Richard D Wagner 1 Apr 1976 25 p refs  
(NASA-TM-X-72833) Avail NTIS HC \$3.50 CSCL 01C

Changes in future aircraft technology which conserve energy are studied, along with the effect of these changes on economic performance. Among the new technologies considered are laminar-flow control, composite materials with and without laminar-flow control, and advanced airfoils. Aircraft design features studied include high-aspect-ratio wings, thickness ratio and range. Engine technology is held constant at the JT9D level. It is concluded that wing aspect ratios of future aircraft are likely to significantly increase as a result of new technology and the push of higher fuel prices. Composite materials may raise aspect ratio to about 11 to 12 and practical laminar flow-control systems may further increase aspect ratio to 14 or more. Advanced technology provides significant reductions in aircraft take-off gross weight, energy consumption, and direct operating cost. Author

**N76-20126\*** Sikorsky Aircraft, Stratford, Conn  
**RSRA SIXTH SCALE WIND TUNNEL TEST Final Report,**  
 Mar - Nov 1974  
 R Flemming and A Ruddell 4 Dec 1974 690 p refs  
 (Contract NAS1-13000)  
 (NASA-CR-144964 SER-72011) Avail NTIS HC \$16 25 CSCL  
 01A

The sixth scale model of the Sikorsky/NASA/Army rotor systems research aircraft was tested in an 18-foot section of a large subsonic wind tunnel for the purpose of obtaining basic data in the areas of performance stability and body surface loads. The model was mounted in the tunnel on the struts arranged in tandem. Basic testing was limited to forward flight with angles of yaw from -20 to +20 degrees and angles of attack from -20 to +25 degrees. Tunnel test speeds were varied up to 172 knots ( $q = 96$  psf). Test data were monitored through a high speed static data acquisition system linked to a PDP-6 computer. This system provided immediate records of angle of attack, angle of yaw, six component force and moment data and static and total pressure information. The wind tunnel model was constructed of aluminum structural members with aluminum fiberglass, and wood skins. Tabulated force and moment data, flow visualization photographs, tabulated surface pressure data are presented for the basic helicopter and compound configurations. Limited discussions of the results of the test are included. Author

**N76-20127#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abteilung Entwurfsaerodynamik

**THREE COMPONENT MEASUREMENTS ON A LIGHT STOL AIRCRAFT WITH CHORDWISE BLOWING**

Horst Koerner and Reinhard Loehr (A Piller KG, Osterode, West Ger) 7 Nov 1975 23 p refs In GERMAN ENGLISH summary. Report will also be announced as translation (DLR-FB-75-74) Avail NTIS HC \$3 50 DFVLR, Cologne DM 10,20

Investigations on a STOL-airplane with internally blown flaps are described. To avoid flow separation on the wing slots were located behind the nose flap and in front of the trailing edge flap. Maximum lift and optimum L/D were investigated as well as the effectiveness of the aileron and the horizontal tail.

Author (ESA)

**N76-20128#** European Space Agency Paris (France)  
**THE DESIGN OF UNSWEPT LARGE ASPECT RATIO WINGS WITH FLAPS FOR TWO FLIGHT CONDITIONS**

Gunter Redeker Dec 1975 37 p refs Transl into ENGLISH of Auslegung von ungeflechten Tragflugeln grossen Seitenverhaeltnisses mit Woelbklappen fuer zwei Entwurfspunkte, DFVLR Brunswick Report DLR-FB-75-34 10 Apr 1975. Original German report available from DFVLR Cologne DM 14 80 (ESA-TT-224 DLR-FB-75-34) Avail NTIS HC \$4 00

The method described is carried out by using flaps covering the whole span which have to be deflected in such a way as to obtain a minimum drag. Calculations are done quickly with a computer program for the line lifting theory which incorporates the influence of flaps. The method is explained with the help of an example of an existing sailplane. Author (ESA)

**N76-20129#** Ohio State Univ Columbus Dept of Mechanical Engineering

**INVESTIGATION OF ACCELERATED LIFE PREDICTION TECHNIQUES Final Report, 1 Mar, 1974 - 28 Feb 1975**

Jack A Collins and Ben Tarver Hagan Jr Oct 1975 61 p refs  
 (Contract DAAJ02-74-C-0033 DA Proj 1F2-62203-AH-86)  
 (AD-A016925 USAAMRD-LR-75-38) Avail NTIS CSCL 01/3

The objectives of the work reported were to define potentially useful failure prediction models for the wear and fretting-wear modes of failure, to define the parameters of primary importance to incorporate the concept of accelerated testing both in the prediction models and in the design of a testing program and to design special testing machines capable of both real-time and accelerated-wear and fretting-wear tests using a UH-1H

helicopter cyclic servo support bearing as the test specimen. This particular component was selected because it was a relatively simple example of an actual component in which both wear and fretting-wear failure modes had been regularly observed in the field. GRA

**N76-20130#** Lockheed-California Co Burbank  
**INCREASED ROTOR BLADE SURVIVABILITY Final Report,**  
 1 Jul 1973 - 1 Jul 1975

C F Griffin Aug 1975 88 p refs  
 (Contract DAAJ02-73-C-0101 DA Proj 1F1-63208-DB-52)  
 (AD-A016929 LR-26700 USAAMRD-LR-75-6) Avail NTIS CSCL 01/3

Reported are results of a program to investigate the feasibility of using composite geodesic structure for the blade spar to increase survivability of helicopter main rotor blades. The design investigated consists of a geodesic truss structure spare of elliptical cross section comprised of elements forming a redundant grid-work. This spar is covered with a thin composite expendable skin that forms the airfoil contour. Parametric analyses were conducted to determine the effects of geometry and materials on the strength and stiffness of geodesic structures. Subscale sections of the graphite/epoxy geodesic main rotor blade box spar were fabricated and tested. A graphite/epoxy geodesic helicopter main rotor blade preliminary design was completed, and four full-scale segments of this blade were fabricated and subjected to structural and ballistic tests. GRA

**N76-20131#** Army Air Mobility Research and Development Lab Fort Eustis Va

**FLIGHT TEST OF THE AEROSPATIALE SA-342 HELICOPTER**

Duane R Simon and Jimmie C Savage Aug 1975 74 p  
 (AD-A016921 USAAMRD-LR-75-44) Avail NTIS CSCL 01/3

The Eustis Directorate of the U S Army Air Mobility Research and Development Laboratory conducted an evaluation of the Aerospatiale Model SA-342 during November 1974. A total of 10 hours 20 minutes of flight time was accumulated during give test flights. Performance, stability and control tests were performed to evaluate the increased capabilities of the SA-342 over the SA-341 upon which the design of the SA-342 is based. Both helicopters have fan-in-fin type antitorque control. The SA-342's handling qualities were generally very good and it exhibited improved lateral-directional stability over the SA-341, however trimming the aircraft directionally within the sideslip deadband was still difficult. The improved fan provided sufficient control moment to attain 50 knots in sideward flight. It is recommended that additional effort be expended to explore and resolve problems with the fan-in-fin design experimental both by Aerospatiale and by Sikorsky Aircraft. GRA

**N76-20134#** Air Force Systems Command Wright-Patterson AFB Ohio Foreign Technology Div

**COCKPIT SYSTEMS STUDY YAK 40 RATING OF COCKPIT FACILITIES, FLIGHT AND SYSTEMS PROPERTIES OF THE AIRCRAFT BY PILOTS**

K Steininger and G Neumann 25 Jun 1975 64 p refs  
 Transl into ENGLISH from Deut Luft Raumfahrt Forschungsber (Munich), v 75 no 15 1975 p 1-70  
 (AD-A017198, FTD-ID(RS)1-1265-75) Avail NTIS CSCL 01/2

An assessment by a representative sample of pilots employed by an airline to operate the Russian short haul jet transport plane YAK 40 is made of several features. Acceptability of the cockpit layout and instrumentation, handling qualities, feasibility of the systems with regard to the pilot's workload. GRA

**N76-20135#** ARO Inc Arnold Air Force Station Tenn  
**EFFECT OF THE GBU-15 (CRUCIFORM WING) AND GBU-15 (PLANAR WING) STORES ON THE AERODYNAMIC CHARACTERISTICS OF THE F-4C AIRCRAFT Final Report**

Eddie S Washington AEDC Sponsored by the AF Nov 1975 69 p refs (AF Proj 2567)

(AD-A017378 ARO-PWT-TR-75-121 AEDC-TR-75-116 AFATL-TR-75-111) Avail NTIS CSCL 01/3

A wind tunnel investigation was conducted to assess the effect of carriage of the GBU-15 (cruciform wing) and the GBU-15 (planar wing) stores on the longitudinal stability and drag characteristics of the F-4C aircraft. Data were obtained for 15 external store loading configurations for angles of attack ranging from -4 to 20 deg at 0-deg roll angle. All data were obtained at a constant stagnation pressure of 2 500 psia for Mach numbers from 0.6 to 1.1. GRA

**N76-20136#** Perkin-Elmer Corp Norwalk Conn  
**DEVELOPMENT OF DEICING TECHNIQUES FOR DIELECTRIC WINDOWS** Final Report, Apr 1973 - Apr 1975

Edward A Strouse Aug 1975 143 p refs

(Contract F33615-73-C-1080 AF Proj 7371)

(AD-A017097, PE-12464 AFML-TR-75-99) Avail NTIS CSCL 01/3

This report covers measurements and techniques that have led to the development of the first prototype windows coated with a continuous thin-film heater transparent in the 8 to 12 micron spectral region. The effort involved the measurement of the complex optical constants of indium-tin-oxide and the dependence of these values on both process parameters and the conductivity of the films. The performance of a full coated window has a transmission greater than 70% and a sheet resistance of 160 ohms/square is described. Also included is a thermo-optical analysis of conductive films and patterns for zinc sulfide, zinc selenide, and zinc sulfo-selenide windows. GRA

**N76-20138+** Royal Netherlands Aircraft Factories Fokker Schiphol-Oost

**BIBLIOGRAPHY ON AIRCRAFT NOISE**

G K Troost Aug 1975 47 p refs

(FOK-N-00-28) Avail NTIS HC \$4.00

Published literature concerning pure aerodynamic noise and its attenuation is listed. Noise from the intake and exhaust of the set engine of aircraft propeller noise, detached flow and boundary layer noise, slits and resonant cavities, local vortices and wakes of struts and antennas are considered. Propagation problems such as atmospheric attenuation, ground absorption and various shielding techniques are also discussed. ESA

**N76-20146\*#** Pratt and Whitney Aircraft East Hartford Conn  
**DESIGN OF A 4 1/2 STAGE TURBINE WITH A STAGE LOADING FACTOR OF 4.66 AND HIGH SPECIFIC WORK OUTPUT** Final Report

P F Webster Washington NASA Mar 1976 138 p refs (Contract NAS3-18033)

(NASA-CR-2659, PWA-5101) Avail NTIS HC \$6.00 CSCL 21E

The aerodynamic design of a highly loaded multistage fan drive turbine is discussed. Turbine flowpath and airfoil sections are presented along with respective pressure and velocity distributions. Vibrational modes are identified in the expected turbine operating range. Author

**N76-20148#** Marquardt Corp Van Nuys Calif  
**LOW COST HYPERMIXING EJECTOR RAMJET PROGRAM** Final Report, 15 Jun 1973 - 10 Feb 1975

Joseph G Bendot, Wallace G Harkins and Thomas G Piercy Wright-Patterson AFB Ohio ARL 8 Jun 1975 199 p refs (Contract F33615-73-C-4093, AF Proj 7116)

(AD-A016430 MR-S-1322-A ARL-75-0219) Avail NTIS CSCL 21/5

The Air Force Aerospace Research Laboratories (ARL) recently made a technology breakthrough in the field of turbulent mixing. ARL experiments indicated that the spreading rate of a subsonic jet may be increased dramatically by the introduction of streamwise vortices in the flow. These vortices promote efficient turbulent mixing within an extremely short distance, i.e., hypermixing. The

basic objective of this program was to assess the payoff if any of applying hypermixing ejector technology to the design of a low cost ejector ramjet engine. Three variations of the ejector ramjet engine cycle were evaluated at the engine design point of Mach 0.75 at 20 000 feet altitude. The fuel addition-mix/diffuse/burn cycle variation was clearly superior. The selected fuel was UDMH. Engine performance was estimated for the specified flight envelope. Mo equals 0.70 to 1.20 and sea level to 30 000 feet altitude. An annular ring ejector which incorporated hypermixing technology was designed, fabricated and experimentally evaluated. Test results showed no improvement with the hypermixing ejector as compared to a conventional annular ejector. The test ejector was then modified. A second test series showed this modification to be very effective. Full mixing (maximum mixer total pressure) was achieved in one half the length required for the annular/initial hypermixing ejector. At the ejector design point, full mixing was accomplished in 1.7 duct diameters. GRA

**N76-20151\*#** Systems Technology Inc Hawthorne Calif  
**MANUAL AND AUTOMATIC FLIGHT CONTROL DURING SEVERE TURBULENCE PENETRATION** Final Report

Donald E Johnston, Richard H Klein and Roger H Hoh Washington NASA Apr 1976 110 p refs

(Contract NASw-2624)

(NASA-CR-2677 TR-1049-1) Avail NTIS HC \$5.50 CSCL 01C

An analytical and experimental investigation of possible contributing factors in jet aircraft turbulence upsets was conducted. Major contributing factors identified included autopilot and display deficiencies, the large aircraft inertia and associated long response time and excessive pilot workload. An integrated flight and thrust energy management director system was synthesized. The system was incorporated in a moving-base simulation and evaluated using highly experienced airline pilots. The evaluation included comparison of pilot workload and flight performance during severe turbulence penetration utilizing four control/display concepts: manual control with conventional full panel display, conventional autopilot (A/P-A) with conventional full panel display, improved autopilot (A/P-B) with conventional full panel display plus thrust director display, and longitudinal flight director with conventional full panel display plus thrust director display. Simulation results show improved performance, reduced pilot workload, and a pilot preference for the autopilot system controlling to the flight director command and manual control of thrust following the trim thrust director. Author

**N76-20152#** European Space Agency Paris (France)  
**MEASUREMENTS OF THE VERTICAL MOVEMENTS OF AN AIRCRAFT**

Heinz Winter et al Dec 1975 80 p refs. Transl into ENGLISH of Messung der Vertikalbewegungen eines Flugzeugs DFVLR, Brunswick Report DLR-FB-75-41 5 May 1975. Original German report available from DFVLR, Cologne DM 28.00.

(ESA-TT-215 DLR-FB-75-41) Avail NTIS HC \$5.00

The measuring accuracy for aircraft altitude and vertical velocity, which can be obtained by combining the information of the vertical channel of an inertial navigation system of a barometric altimeter and of a tracking radar in a Kalman filter, was analyzed. Results are based on a flight test with the HFB 320 aircraft. Author (ESA)

**N76-20153#** Naval Postgraduate School Monterey Calif  
**A COMPARISON OF OPTIMAL CONTROL THEORY PREDICTIONS WITH ACTUAL PILOT PERFORMANCE IN A HELICOPTER LONGITUDINAL TRACKING TASK** M S Thesis

Luther William Wheat Jun 1975 44 p refs

(AD-A016441) Avail NTIS CSCL 01/3

A fixed base helicopter simulation was implemented which may be easily altered to represent a variety of conventional single rotor aircraft. Test subjects performed 90-second tracking tasks utilizing two cockpit displays for longitudinal control during landing approach. The performance data generated were compared with predicted values from an optimal pilot modeling technique. Tentative conclusions were drawn as to the effectiveness of each display as well as the predictive power of the pilot model. GRA

**N76-20154#** Honeywell Inc Minneapolis Minn Government and Aeronautical Products Div  
**ROLL-AXIS HYDROFLUIDIC STABILITY AUGMENTATION SYSTEM DEVELOPMENT** Final Report, 29 Mar 1973 - 30 Sep 1974

Darroll Bengtson Thomas Dickovich, and Robert Helfenstine Sep 1975 137 p  
 (Contract DAAJ02-73-C-0056, DA Proj 1F1-62204-AA-44)  
 (AD-A016932 GAPD-W0528-FR USAAMRDL-TR-75-43) Avail NTIS CSCL 01/3

The objective of this program was to develop, design, and flight test a roll-axis Hydrofluidic Stability Augmentation System (HYSAS) for the OH-58A helicopter. The system when used with a yaw HYSAS provides increased vehicle damping which improves the handling characteristics. Flight test evaluations were performed with satisfactory results. GRA

**N76-20156#** National Research Council of Canada, Ottawa (Ontario)

**[MECHANICAL ENGINEERING AND AERONAUTICAL RESEARCH PROJECTS]** Quarterly Bulletin, 1 Oct - 31 Dec 1975

31 Dec 1975 90 p refs  
 (DME/NAE-1975(4) ISSN-0047-9055) Avail NTIS HC \$5 00

Lift fan noise reduction and a Canadian playback and flight recording center for aircraft accident and/or incident investigations are summarized.

**N76-20169#** Air Force Flight Dynamics Lab Wright Patterson AFB Ohio

**FEASIBILITY DETERMINATION OF A DYNAMIC TAXI FACILITY FOR EVALUATING MILITARY LANDING GEAR SYSTEMS** Final Report, May - Dec 1973

Howard T Anderle and Joseph G Mercer Jul 1975 103 p refs  
 (AF Proj 1369)  
 (AD-A017038 AFFDL-TR-74-111) Avail NTIS CSCL 01/3

A feasibility study of using a hydraulic vibration machine in conjunction with a drop tower to evaluate ride quality characteristics of a landing gear was made. For sinusoidal inputs over a frequency-double amplitude range of 1-5 Hz and 0.6 to 1.0 inches amplitude-ratio frequency response of the drop jig was measured. This was done while varying strut pneumatic stiffness and strut friction. This work definitely shows feasibility of a laboratory experimental setup to test ride quality effectiveness of a landing gear. GRA

**N76-20232#** Southwest Research Inst San Antonio Tex  
**DESIGN OF A TEST MACHINE FOR BIAxIAL TESTING OF COMPOSITE-LAMINATE CYLINDERS** Final Report, May 1974 - Apr 1975

U S Lindholm A Nagy L M Yeakley and W L Ko Wright-Patterson AFB, Ohio AFFDL Jul 1975 82 p refs  
 (Contract F33616-74-C-0043 AF Proj 1467)  
 (AD-A016961 AFFDL-TR-75-83) Avail NTIS CSCL 14/2

A design is presented for a facility to test composite laminate tubes under generalized plane stress loading conditions. The system is designed around multiple closed-loop servo-controlled hydraulic load actuators to provide independent programmable axial, circumferential and torsional stress to tubular specimens. The unique feature of the design is an actively controlled hydraulic, collet-type grip. The grip is designed to provide radial displacement of the collet to compensate for deformation in the specimen during loading. This radial compensation is shown to significantly reduce the grip induced constraint stresses which previously have been a serious problem in the testing of composite tubes. GRA

**N76-20301#** Transportation Systems Center Cambridge Mass  
**AIRCRAFT L-BAND BALLOON SIMULATED SATELLITE EXPERIMENTS VOLUME 1 EXPERIMENT DESCRIPTION AND DATA MODEM TEST RESULTS** Final Report, Sep 1971 - Nov 1973

Peter D Engels and Robert A Wilson Oct 1975 140 p refs  
 (AD-A017090 DOT-TSC-FAA-74-24-Vol-1  
 FAA-RD-75-174-Vol-1) Avail NTIS HC \$6 00 CSCL 17/2

The result of an experiment intended to evaluate candidate voice and data modulation systems for use in an L-Band Air Traffic Control System was described. The experiment was designed to evaluate performance in the presence of oceanic multipath using a high altitude balloon carrying an L-Band transponder as a geostationary satellite simulator. The voice modems chosen were Delta Modulation Pulse Duration Modulation and Adaptive Narrow-Band Frequency Modulation. The data modems used employed PSK modulation with coherent demodulation. Author

**N76-20339#** Michigan Univ Ann Arbor Radiation Lab  
**A STUDY OF AXIAL SLOT ARRAYS ON A CIRCULAR CYLINDER FOR USE ON ELECTRICALLY SMALL VEHICLES** Final Report, 15 Sep 1974 - 30 Jun 1975

Dipak L Sengupta and Joseph E Ferris Sep 1975 67 p refs

(Contract F19628-75-C-0036 AF Proj 5635)  
 (AD-A016564 UMICH-013367-1-f, AFCL-TR-75-0466) Avail NTIS CSCL 09/5

Radiation patterns produced by arrays of axial slots on a conducting cylinder are studied theoretically and experimentally to develop directive antenna systems for use on electrically small aircraft or missiles. The design of the array is mainly governed by the considerations of required field discriminations between various directions. A method has been developed for the design of a reduced-height waveguide cavity-backed slot which can be used as an individual radiating element of the array. Impedance and radiating properties of the slot element are studied and discussed. GRA

**N76-20360#** Army Electronics Command Fort Monmouth NJ  
**ROTOR BLADE EFFECTS ON L-BAND SIGNALS RECEIVED BY HELICOPTER ANTENNAS MOUNTED ABOVE THE ROTOR BLADE (CW) EXPERIMENTS** Final Experimental Report for 1974

C M DeSantis and F Schwering Oct 1975 118 p

(DA Proj 1T1-61102-B-31A)

(AD-A016866 ECOM-4357) Avail NTIS CSCL 09/5

Rotor effects on L-Band signals received by helicopter antennas have been examined experimentally. CW data for two receiving-antenna locations above the rotor blade viz at the turning axis of the blade and on the tail, is presented. This data shows the amplitude and phase variations to be expected as a function of the direction of the incident signal. The effects of counterpoise size and height above the main rotor are also studied. In general it is shown that the signal variations were typically < plus or minus 3 db for polar angles of arrival  $\theta$  < or equal to 70 deg but that for greater angles the signal amplitude changes by as much as plus or minus 7 db. For  $\theta = 90$  deg (an arrival angle obtained for instance during a turning and banking maneuver) signal levels can decrease by minus 15 db and the phase variation can exceed 180 deg. The tail location appears to be a better choice for the antenna than the center location. A worst-case analysis of CW rotor effects is presented in Appendix I. Appendices II and III contain some of the data measured at both antenna locations and should be referred to for a better understanding of the signal variations involved. Author (GRA)

**N76-20386#** Aerospace Corp, El Segundo Calif Lab Operations

**FLIGHT TEST EVALUATION OF A 240 TO 400 MHz CAVITY-BACKED CROSS OPEN-SLEEVE DIPOLE ANTENNA** Test Report

Lowell R Nawman and Howard E King 10 Oct 1975 34 p refs  
(Contract F04701-75-C-0076)  
(AD-A017298 TR-0076(6401)-1 SAMSO-TR-75-241) Avail  
NTIS CSCL 09/5

The gain and radiation patterns of a cavity-backed open-sleeve cross dipole antenna mounted on a C135-type aircraft were measured via a satellite-to-aircraft link at 249.1 MHz. The antenna was designed for operation over the 240 to 400 MHz frequency band and has maximum dimensions of 21.5 in square by 6 in deep. For the purposes of the aircraft flight tests, the antenna was externally mounted to the fuselage and covered with a radome. The gain and radiation patterns of the antenna measured in the antenna range with the cavity mounted on a 9.5-ft by 9.5-ft cylindrically curved ground plane are also shown for comparison. GRA

**N76-20387#** Aerospace Corp El Segundo Calif Lab Operations

**CHARACTERISTICS OF A 240 TO 400 MHz 6-INCH DEPTH CAVITY-BACKED CROSS OPEN-SLEEVE DIPOLE ANTENNA ON A CURVED GROUND PLANE** Final Report, Dec 1973 - May 1974

H E King J L Wong and C E Ermatinger 31 Oct 1975 31 p refs

(Contract F04701-75-C-0076)  
(AD-A017367 TR-0076(6401)-2 SAMSO-TR-75-224) Avail  
NTIS CSCL 09/5

An open-sleeve cross dipole antenna contained within a 21.5 in square x 6 in deep cavity is described for operation in the 240 to 400 MHz band. The antenna was developed for an aircraft flight test evaluation using a satellite-to-air communication link. For the purposes of these flight tests on a KC-135 aircraft the antenna was externally mounted to the fuselage and covered with a radome. Measured VSWR, radiation patterns and gain with the antenna mounted on a 9.5 ft x 9.5 ft cylindrically curved ground plane are shown. GRA

**N76-20455#** Air Force Aero Propulsion Lab Wright-Patterson AFB Ohio

**TESTING A FLUIDIC TEMPERATURE SENSOR ON A SUBSCALE RAMJET ENGINE COMBUSTION CHAMBER** Technical Report, Sep - Dec 1973

John T Hojnacki Jun 1975 135 p refs  
(AF Proj 3012)

(AD-A016455 AFAPL-TR-75-1) Avail NTIS CSCL 13/7

Data obtained from 26 tests that used three fluidic temperature sensors to measure gas temperatures in a subscale ramjet engine combustion chamber are presented. The test variables for the combustion chamber were chamber pressure and chamber temperature. Tests were conducted using nominal chamber pressures of 35 and 70 psia and chamber total temperatures of 2500 R, 3000 R and 3800 R. One of the sensors used various insulator materials which were magnesium oxide, Hastelloy X and zirconium oxide. These materials varied the conduction heat losses from the sensor body to the outer case. The mass flow through a sensor was increased by a factor of three to see if improvements could be made in reducing steady state error or increasing thermal response. Lastly one test was conducted using an ablative lined combustion chamber that provided a long duration run. GRA

**N76-20545#** Naval Intelligence Support Center Washington DC

**CALCULATION OF THE REINFORCED THIN-WALLED STRUCTURES BY THE METHOD OF FINITE ELEMENTS**

Yu I Ivanov 30 Sep 1975 15 p Transl into ENGLISH from Tsentralnyi Aerogidrodinamicheskii Inst Uchenye Zapiski (USSR) v 3 no 1 1972 p 51-60

(AD-A016387 NISC-Trans-3692) Avail NTIS CSCL 13/13

One variant of the finite element method is presented as applicable for calculations of the reinforced thin-walled structures (flat and curved panels, wings and empennage of different schemes

fuselage sections). The applicability of the method coupled with a computer programming is illustrated by several actual calculations. Theoretical results are compared with experimental data. GRA

**N76-20695#** Committee on Science and Technology (U S House)

**AIRCRAFT NOISE ABATEMENT**

Washington GPO 1975 300 p refs Hearings before Subcomm on Aviation and Transportation R and D of Comm on Sci and Technol 94th Congr, 1st sess No 38 29 Sep 1-2 Oct 1975

(GPO-62-786) Avail Subcomm on Aviation and Transportation R and D

Developments in aircraft noise abatement technology are assessed. Topics discussed include control and identification of aircraft noise sources, the noise path between the aircraft and the observer on the ground, and identification of community noise exposure and psychoacoustic responses. Emphasis is placed on development of future research and development programs dealing with noise abatement technology. J M S

**N76-20940\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**PREDICTION OF LIGHT AIRCRAFT INTERIOR NOISE**

James T Howlett and David A Morales Apr 1976 21 p refs

(NASA-TM-X-72838) Avail NTIS HC \$3.50 CSCL 20A

A computerized interior noise prediction method for light aircraft is described. An existing analytical program development for commercial jets forms the basis of some modal analysis work which is described. The accuracy of this modal analysis technique for predicting low-frequency coupled acoustic-structural natural frequencies is discussed along with trends indicating the effects of varying parameters such as fuselage length and diameter, structural stiffness, and interior acoustic absorption. Author

**N76-20941\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**A COMPARISON OF MATRIX METHODS FOR CALCULATING EIGENVALUES IN ACOUSTICALLY LINED DUCTS**

Willie Watson and Donald L Lansing Washington Mar 1976 47 p refs

(NASA-TN-D-8186 L-10607) Avail NTIS HC \$4.00 CSCL 20A

Three approximate methods - finite differences, weighted residuals, and finite elements - were used to solve the eigenvalue problem which arises in finding the acoustic modes and propagation constants in an absorptively lined two-dimensional duct without airflow. The matrix equations derived for each of these methods were solved for the eigenvalues corresponding to various values of wall impedance. Two matrix orders, 20 x 20 and 40 x 40, were used. The cases considered included values of wall admittance for which exact eigenvalues were known and for which several nearly equal roots were present. Ten of the lower order eigenvalues obtained from the three approximate methods were compared with solutions calculated from the exact characteristic equation in order to make an assessment of the relative accuracy and reliability of the three methods. The best results were given by the finite element method using a cubic polynomial. Excellent accuracy was consistently obtained even for nearly equal eigenvalues by using a 20 x 20 order matrix. Author

**N76-20942#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Berlin (West Germany) Inst fuer Turbulenzforschung

**THE AMPLIFICATION OF BROADBAND JET NOISE BY PURE TONE EXCITATION**

Dietrich Bechert and Eberhard Pfizenmaier 6 Nov 1975 25 p refs In GERMAN ENGLISH summary Report will also be announced as translation

(DLR-FB-75-72) Avail NTIS HC \$3.50 DFVLR Cologne DM 10.40

It was found experimentally that broad band jet noise can be amplified as much as 6 to 7 dB. The jet noise amplification

effect takes place at sound pressure levels present in real aircraft engines. The experimental investigation was restricted to a cold jet at high subsonic Mach numbers excited by a plane sound wave coming from inside the nozzle. Based on a simplified mathematical model an attenuator was developed which reduces the jet noise amplification significantly. Author (ESA)

**N76-21017#** Air Force Inst of Tech Wright-Patterson AFB Ohio School of Systems and Logistics  
**THE IDENTIFICATION OF A PRECEDENCE NETWORK ASSOCIATED WITH BASE LEVEL AIRCRAFT MAINTENANCE** M S Thesis

Clark D Hubbard and Charles R Lindke Aug 1975 157 p refs

(AD-A016389 SLSR-12-75B) Avail NTIS CSCL 15/5

The objective of this study was to develop a method of identifying precedence networks associated with aircraft maintenance that is more efficient than totally relying on the memory and experience of mechanics in the field. A precedence network is the sequence in which tasks should be performed because of their interdependencies. An example of this type of dependency would be the necessity to repair a fuel cell before refueling an aircraft. This research involved the use of the Logistic Composite Model (L-COM) developed by Headquarters Air Force Logistics Command and the Rand Corporation the F-4E data base which had been constructed as part of Headquarters Tactical Air Command's L-COM Study and Maintenance Data Collection System records for F-4E aircraft. GRA

**N76-21024#** General Dynamics/Convair San Diego Calif  
**WEAPON SYSTEM COSTING METHODOLOGY FOR AIRCRAFT AIRFRAMES AND BASIC STRUCTURES VOLUME 2 ESTIMATING HANDBOOK AND USER'S MANUAL, PART 1** Final Report. Jul 1972 - Feb 1975

R E Kenyon May 1975 184 p

(Contract F33615-72-C-2083 AF Proj 1368)

(AD-A016409 AFFDL-TR-75-44-Vol-2-Pt-1) Avail NTIS CSCL 01/3

This volume provides a detailed description of the function and use of two weapon system costing methodologies for aircraft airframes and basic structures developed for the Air Force Flight Dynamics Laboratory for use in conceptual and preliminary designs phases of weapon system development. The methods are a trade study costing method for detailed cost analysis of trades-off between weight cost type of construction and type of material and a system costing method for determining the projected cost of a complete airframe within the context of a weapon system development. This volume describes how to make an estimate using either technique and shows the results of a demonstration case. Tradeoff capability has been provided for a range of alternative structure and material combinations. A technique for independent assessing complexity factor has been developed and demonstrated. Manufacturing costs are separately estimated for the primary elements of substructure ribs spars covers leading edges trailing edges tips etc. The trade study method provides an iterative capability stemming from a direct interface with design synthesis programs. A detailed cost data base and system for data expansion are provided. The methods are designed for ease in changing cost estimating relationships and estimating coefficients resulting from cost data update. Author (GRA)

**N76-21152** Engineering Sciences Data Unit London (England)  
**CRITICAL PRESSURE COEFFICIENT AND COMPONENT OF LOCAL MACH NUMBER NORMAL TO THE SURFACE ISOBAR FOR A SWEEP WING**

Oct 1975 6 p

(ESDU-75027) For information on availability of series sub-series and other individual data items, write, NTIS Attn ESDU, Springfield Va 22161 HC \$74 50

In the analysis of measured pressure distribution data on a swept wing at high speeds it is often required to establish those areas over which supercritical flow exists to interpret the flow in terms of local Mach number (particularly the maximum value) and to identify the location and strength at the wing surface of

any shock waves that might occur in the flow. These features are governed by the distribution over the wing surface to the component of local Mach number normal to the isobars. The report provides a means of estimating the component of local Mach number normal to the surface isobar and the critical pressure coefficient for a swept wing. The method is based on simple-sweep theory and would therefore be expected to apply to wings of moderate to high aspect ratio and low taper. ESDU

**N76-21153** Engineering Sciences Data Unit, London (England)  
**DRAG DUE TO GROOVES IN A FLAT PLATE WITH TURBULENT BOUNDARY LAYER, AT SUBSONIC AND SUPERSONIC SPEEDS**

Nov 1975 13 p

(ESDU-75028) For information on availability of series sub-series and other individual data items write NTIS Attn ESDU, Springfield Va 22161 HC \$122 50

Item No 75028 is the third in the series of items concerning excrescence drag estimation. It provides a method for estimating incremental drag coefficients due to grooves in a flat plate with a turbulent boundary layer at subsonic (M less than or equal to 0.8) and supersonic (M greater than or equal to 1.4) speeds. Grooves normal, streamwise and oblique to the flow are catered for, although the data for other than normal grooves are somewhat tentative, being based on very limited experimental data for low-speed flow only. In the design of an aircraft the item will be found useful in assessing the drag penalty due to gaps around say access hatch doors and at the skin butt joint between two wing on fuselage panels. ESDU

**N76-21158\*#** Cincinnati Univ Ohio Dept of Aerospace Engineering

**DYNAMICS AND IDENTIFICATION OF FLEXIBLE AIRCRAFT**

William R Wells Washington NASA Apr 1976 68 p refs (Grant NGR-36-004-061)

(NASA-CR-2672) Avail NTIS HC \$4 50 CSCL 01C

The equations of motion and a maximum likelihood parameter identification formulation are developed for a flexible aircraft. The various levels of approximation associated with the modal substitution representation of the elastic displacement field are discussed and illustrated when appropriate. The necessary extension of the parameter set of stability and control derivatives due to the aeroelastic effects is obtained. Author

**N76-21159\*#** Rockwell International Corp Los Angeles Calif Aircraft Div

**SMALL SCALE NOISE AND WIND TUNNEL TESTS OF UPPER SURFACE BLOWING NOZZLE FLAP CONCEPTS VOLUME 1 AERODYNAMIC TEST RESULTS**

Dirk J Renselaer Roy S Nishida and Clayton A Wilkin Dec 1975 143 p refs

(Contract NAS2-8607)

(NASA-CR-137747) Avail NTIS HC \$6 00 CSCL 01A

The results and analyses of aerodynamic and acoustic studies conducted on the small scale noise and wind tunnel tests of upper surface blowing nozzle flap concepts are presented. Various types of nozzle flap concepts were tested. These are an upper surface blowing concept with a multiple slot arrangement with seven slots (seven slotted nozzle) an upper surface blowing type with a large nozzle exit at approximately mid-chord location in conjunction with a powered trailing edge flap with multiple slots (split flow or partially slotted nozzle). In addition aerodynamic tests were continued on a similar multi-slotted nozzle flap but with 14 slots. All three types of nozzle flap concepts tested appear to be about equal in overall aerodynamic performance but with the split flow nozzle somewhat better than the other two nozzle flaps in the landing approach mode. All nozzle flaps can be deflected to a large angle to increase drag without significant loss in lift. The nozzle flap concepts appear to be viable aerodynamic drag modulation devices for landing. Author

**N76-21160\*#** Rockwell International Corp Los Angeles Calif  
**SMALL SCALE NOISE AND WIND TUNNEL TESTS OF UPPER SURFACE BLOWING NOZZLE FLAP CONCEPTS VOLUME 2 ACOUSTIC TEST RESULTS**

Yoram Kadman Jan 1976 100 p refs Prepared by Bolt Beranek and Newman Inc Cambridge Mass (Contract NAS2-8607) (NASA-CR-137748 BBN-3130) Avail NTIS HC \$5 00 CSCL 01A

Results are summarized of acoustic tests on two advanced concepts of upper-surface-blowing propulsive lift devices Author

**N76-21161\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**VORTEX MANEUVER LIFT FOR SUPER-CRUISE CONFIGURATIONS**

James F Campbell, Blair B Gloss and John E Lamar Feb 1976 26 p refs (NASA-TM-X-72836) Avail NTIS HC \$4 00 CSCL 01A

Some of the theoretical and experimental research conducted at the NASA Langley Research Center is presented to investigate the subsonic vortex-lift producing capabilities for two classes of Super-Cruise designs a close-coupled wing-canard arrangement and a slender wing configuration In addition several analytical methods are discussed for estimating critical structural design loads for thin highly swept wings having separated leading-edge vortex flows Author

**N76-21162\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif  
**STABILITY OF ELASTIC BENDING AND TORSION OF UNIFORM CANTILEVER ROTOR BLADES IN HOVER WITH VARIABLE STRUCTURAL COUPLING**

Dewey H O2Ormiston Hodges Robert A Washington Apr 1976 77 p refs Prepared jointly with Army Air Mobility Res and Dev Lab (NASA-TN-D-8192 A-6375) Avail NTIS HC \$5 00 CSCL 01C

The stability of elastic flap bending lead-lag bending and torsion of uniform untwisted cantilever rotor blades without chordwise offsets between the elastic mass tension and aerodynamic center axes is investigated for the hovering flight condition The equations of motion are obtained by simplifying the general nonlinear partial differential equations of motion of an elastic rotating cantilever blade The equations are adapted for a linearized stability analysis in the hovering flight condition by prescribing aerodynamic forces applying Galerkin's method and linearizing the resulting ordinary differential equations about the equilibrium operating condition The aerodynamic forces are obtained from strip theory based on a quasi-steady approximation of two-dimensional unsteady airfoil theory Six coupled mode shapes calculated from free vibration about the equilibrium operating condition are used in the linearized stability analysis The study emphasizes the effects of two types of structural coupling that strongly influence the stability of hingeless rotor blades The first structural coupling is the linear coupling between flap and lead-lag bending of the rotor blade The second structural coupling is a nonlinear coupling between flap bending lead-lag bending, and torsion deflections Results are obtained for a wide variety of hingeless rotor configurations and operating conditions in order to provide a reasonably complete picture of hingeless rotor blade stability characteristics Author

**N76-21163#** Advisory Group for Aerospace Research and Development Paris (France)

**TECHNICAL EVALUATION REPORT OF AGARD SPECIALISTS MEETING ON WINGWITH-STORES FLUTTER**

Walter J Mykytow (AFFDL) Feb 1976 13 p refs Meeting held at Munich 9 oct 1974 during 39th Meeting of Struct and Mater Panel (AGARD-AR-96 ISBN-92-835-1209-X) Avail NTIS HC \$3 50

The carriage of stores on wings significantly changes their dynamic characteristics and often adversely affects their flutter properties as a result of reduced wing frequencies and the introduction of critical frequency ratios together with inertia elastic and aerodynamic coupling between loads Adverse flutter characteristics and significantly lowered flutter speeds occur and these restrictions severely constrain the speed -- altitude performance envelope that can be achieved by an aircraft The

variety of stores that can be carried on modern tactical airplanes generates a need to accurately evaluate the literally thousands of possible store combinations which can be carried by such aircraft Results are presented from a conference on information and procedures in use in the various NATO nations to solve the flutter problems associated with the carriage of external stores on wings Nine presentations were given and are summarized Recommendations concerning possible future efforts on the subject are given Author

**N76-21164\*#** Virginia Polytechnic Inst and State Univ Blacksburg Dept of Aerospace and Ocean Engineering  
**FLUTTER OF ASYMMETRICALLY SWEEPED WINGS**

Terrence A Weisshaar and J B Crittenden 12 Mar 1976 32 p refs Backup document for AIAA Synoptic scheduled for publication in AIAA Journal in Aug 1976 (Grant NsG-2016)

(NASA-CR-146815) Avail NTIS HC \$4 00 CSCL 01A

Two formulations of the oblique wing flutter problem are presented one formulation allows only simple wing bending deformations and rigid body roll as degrees of freedom while the second formulation includes a more complex bending-torsional deformation together with the roll freedom Flutter is found to occur in two basic modes The first mode is associated with wing bending-aircraft roll coupling and occurs at low values of reduced frequency The second instability mode closely resembles a classical bending-torsion wing flutter event This latter mode occurs at much higher reduced frequencies than the first The occurrence of the bending-roll coupling mode is shown to lead to lower flutter speeds while the bending-torsion mode is associated with higher flutter speeds The ratio of the wing mass moment of inertia in roll to the fuselage roll moment of inertia is found to be a major factor in the determination of which of the two instabilities is critical Author

**N76-21165#** Messerschmitt-Boelkow-Blohm G m b H Otto-brunn (West Germany) Unternehmensbereich Flugzeuge  
**COMPUTER PROGRAM FOR CALCULATING PRESSURE DISTRIBUTION AND COEFFICIENTS OF WINGS, BODIES, WING-BODY COMBINATIONS AND WING-TAIL COMBINATIONS IN SUBSONIC, SUPERSONIC AND HYPERSONIC FLOW**

Werner Kraus 13 Nov 1973 147 p refs In GERMAN ENGLISH summary (MBB-UFE-1014-O) Avail NTIS HC \$6 00

The program developed by Boeing was set up on an MBB IBM 370 computer for calculations based on potential theory A comparison with measurements shows the usefulness and universal application of the method Written in FORTRAN 4 the program may be used in design work and calculation within the subsonic supersonic and hypersonic speed range ESA

**N76-21167#** Cranfield Inst of Technology (England) Aerodynamics Div

**SUPERSONIC FLOW PAST A SLENDER DELTA WING AN EXPERIMENTAL INVESTIGATION COVERING THE INCIDENCE RANGE MINUS 5 DEG LESS THAN OR EQUAL TO ANGLE OF INCIDENCE LESS THAN OR EQUAL TO 50 DEG**

I C Richards Oct 1975 36 p refs Sponsored by Min of Defence

(Cranfield-Memo-7512) Avail NTIS HC \$4 00

A detailed survey of a delta wing of 70 deg sweep was performed at 2.5 m in order to produce a delta wing model which could be tested over a wide range of incidence (from -5 to 50 deg) The development of the flow over the delta wing was studied and the transition region between regimes of attached and separated flow on the lee surface investigated The measurements include upper and lower surface pressure distributions schlieren photographs vapor screen photographs, and surface oil flow visualization Results were compared with thin shock-layer theory and various other predictions

Author (ESA)



**N76-21168#** Bristol Univ (England) Dept of Aeronautical Engineering

**THE PRESSURE DISTRIBUTION OVER THE OGIVE NOSE OF A CYLINDER AT LARGE ANGLES OF INCLINATION TO A UNIFORM STREAM**

D J Inker and M Renshaw Jun 1974 188 p refs  
(BU-173) Avail NTIS HC \$7 50

A wind-tunnel was investigated in regard to the surface pressures on an ogive nose of a circular cylinder at angles of inclination between 40 and 70 deg to a uniform airstream for laminar flow Reynolds numbers of  $6 \times 10\,000$  and  $1.2 \times 100\,000$ . Circumferential distributions of pressure coefficient based on the cross flow dynamic pressure at several axial stations along the nose were calculated for each setting of inclination and Reynolds number. Corresponding axial distributions of out-of-plane and in-plane force coefficients per unit length were calculated from the pressure distributions. The results were interpreted in relation to those predicted by the impulsively-started cross flow analogy for a constant diameter cylinder and it was found that the analogy predicts, qualitatively but not quantitatively, the flow development and axial distribution of forces acting on the inclined body. It was found that the asymmetry of the flow as seen in the pressure distributions, occurred in two distinct forms. Author (ESA)

**N76-21169#** Bristol Univ (England) Dept of Aeronautical Engineering

**AN INVESTIGATION INTO THE EFFECT OF CASTELLATING A BLUNT TRAILING EDGE IN SUPERSONIC FLOW**

P R Hosking and D Q Self Jun 1974 38 p refs  
(BU-175) Avail NTIS HC \$4 00

The possibility of reducing the base drag of the blunt trailing edges on Concorde by a method of castellating the trailing edges was examined. It is concluded that castellations produce a 30 % decrease in the base drag but that the same improvement may be achieved from a uniform extension along the whole span of the wing. The investigation was carried out with a value of boundary layer momentum thickness to base height much less than that on Concorde. It is suggested that reductions in base pressures obtained in flight tests are due to effects known to occur with castellations at subsonic velocities rather than any unknown mechanism at supersonic velocities. Author (ESA)

**N76-21170#** Bristol Univ (England) Dept of Aeronautical Engineering

**AN INVESTIGATION INTO THE EFFECTS OF ASPECT RATIO AND CENTRE KEEL CAMBER ON THE AERODYNAMIC CHARACTERISTICS OF CONICAL PARAWINGS**

G P Dave and P L R Martin Jun 1974 51 p refs  
(BU-176) Avail NTIS HC \$4 50

A comparison was made of high and low aspect ratio straight boomed parawings (aspect ratios of 2 and 4) where results similar to those from other investigations were found. The aspect ratio 2 wing produced (L/D) ratios of up to 7 and for the aspect ratio 4 wing after a correction for leading edge boom diameter had been applied (L/D) ratios of over 10 were obtained. Center keel cambers were introduced onto the same two wings. The cambers were such that the spanwise and chordwise slackness ratios of the canopies were the same. Although the maximum values of (L/D) ratios were lower for the cambered wing than the uncambered versions the values of lift coefficient at which they occurred were much higher. There were also large increases in the ranges of incidence for which high (L/D) ratio values were maintained. Using information from previous reports and simple rigid wing theory predictions were made as to the changes in characteristics with changes in aspect ratio and camber. In general the predictions were found to hold the exceptions being due to canopy shape changes. Author (ESA)

**N76-21172#** Air Force Cambridge Research Labs L G Hanscom Field Mass

**INTERACTION OF A BUOYANT TURBULENT PLANAR JET WITH A CO-FLOWING WIND Air Force Surveys in Geophysics**

Milton M Klein and Bruce A Kunkel 10 Jul 1975 38 p refs

(AF Proj 7605)

(AD-A018060 AFCRL-TR-75-0368, AFCRL-AFSG-313) Avail NTIS CSCL 01/2

The classic theory of buoyant motion of a free planar heated jet in still air is extended to account for environmental winds from the same direction as the jet that is co-flowing winds. The model is applicable for wind and jet velocities up to 100 m/sec and jet temperatures up to three times the ambient. Calculations are made for initial jet velocities of 5 and 20 m/sec and temperature excesses, relative to ambient temperature, of 0.3 and 1. For light winds relative to the initial jet velocity the vertical velocity and centerline trajectory of the plume rise rapidly with distance from the jet source. This is similar to that found with the classic theory for still air. As the wind speed approaches the initial jet velocity the rise of the jet plume with distance from the source is much more gradual. For all wind speeds the axial jet velocity and temperature decrease rapidly with distance from the jet source, until they become almost constant at short distances downstream. A similarity rule is derived which preserves dynamic similarity in scaling from a given system to another system. For low wind speeds the procedure is close to that based on constant Froude number. Author (GRA)

**N76-21173\*#** National Aeronautics and Space Administration Langley Research Center Langley Station Va

**IMPACT DYNAMICS RESEARCH FACILITY FOR FULL-SCALE AIRCRAFT CRASH TESTING**

Victor L Jr Vaughan and Emilio Alfaro-Bou Washington Apr 1976 57 p

(NASA-TN-D-8179 L-10514) Avail NTIS HC \$4 50 CSCL 14B

An impact dynamics research facility (IDRF) was developed to crash test full-scale general aviation aircraft under free-flight test conditions. The aircraft are crashed into the impact surface as free bodies. A pendulum swing method is used to obtain desired flight paths and velocities. Flight paths up to -60 deg and aircraft velocities along the flight paths up to about 270 m/s can be obtained with a combination of swing-cable lengths and release heights made available by a large gantry. Seven twin engine 2721-kg aircraft were successfully crash tested at the facility and all systems functioned properly. Acquisition of data from signals generated by accelerometers on board the aircraft and from external and onboard camera coverage was successful in spite of the amount of damage which occurred during each crash. Test parameters at the IDRF are controllable with flight path angles accurate within 8 percent, aircraft velocity accurate within 6 percent, pitch angles accurate to 4.25 deg and roll and yaw angles acceptable under wind velocities up to 4.5 m/s. Author

**N76-21175\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**CHARACTERISTICS OF WAKE VORTEX GENERATED BY A BOEING 727 JET TRANSPORT DURING TWO-SEGMENT AND NORMAL ILS APPROACH FLIGHT PATHS**

R L Kurkowski, M R Barber and L J Garodz Washington Apr 1976 107 p refs

(NASA-TN-D-8222 A-6208) Avail NTIS HC \$5 50 CSCL 01C

A series of flight tests was conducted to evaluate the vortex wake characteristics of a Boeing 727 (B727-200) aircraft during conventional and two-segment ILS approaches. Twelve flights of the B727 which was equipped with smoke generators for vortex marking, were flown and its vortex wake was intentionally encountered by a Lear Jet model 23 (LR-23) and a Piper Twin Comanche (PA-30). Location of the B727 vortex during landing approach was measured using a system of photo-theodolites.

The tests showed that at a given separation distance there were no readily apparent differences in the upsets resulting from deliberate vortex encounters during the two types of approaches. Timed mappings of the position of the landing configuration vortices showed that they tended to descend approximately 91 m (300 ft) below the flight path of the B727. The flaps of the B727 have a dominant effect on the character of the trailed wake vortex. The clean wing produces a strong concentrated vortex but as the flaps are lowered, the vortex system becomes more diffuse. Pilot opinion and roll acceleration data indicate that 4.5 nmi would be a minimum separation distance at which roll control of light aircraft (less than 5,670 kg (12,500 lb) could be maintained during parallel encounters of the B727's landing configuration wake. This minimum separation distance is generally in scale with results determined from previous tests of other aircraft using the small roll control criteria. Author

**N76-21178#** Naval Aerospace Medical Research Lab., Pensacola Fla

**MAJOR ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1971 (ACCIDENT FACTORS)**

W. Carroll Hixson and Emil Spezia. 7 Jul 1975. 32 p. refs. Prepared in cooperation with Army Aeromed Res Lab Fort Rucker Ala (MF51524005)

(AD-A017665 NAMRL-1219 USAARL-76-1) Avail NTIS CSCL 01/2

This report is the fifth in a longitudinal series of reports dealing with the pilot disorientation/vertigo problem in Regular Army UH-1 helicopter operations. Individual case history data extracted from the USAAVS master aircraft accident files are presented on major orientation-error accidents that occurred in UH-1 aircraft during fiscal year 1971. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 31 cases. The listings are arranged to distinguish between those factors and events present before takeoff i.e. the initial conditions associated with a given accident and those which occurred or were manifested during the actual airborne phase of the accident flight. GRA

**N76-21188\*#** Analytical Mechanics Associates, Inc. Jericho NY

**STUDIES OF AIRCRAFT DIFFERENTIAL MANEUVERING REPORT 75-27 CALCULATING OF DIFFERENTIAL-TURNING BARRIER SURFACES REPORT 75-26 A USER'S GUIDE TO THE AIRCRAFT ENERGY-TURN AND TANDEM-MOTION COMPUTER PROGRAMS REPORT 75-7 A USER'S GUIDE TO THE AIRCRAFT ENERGY-TURN HODOGRAPH PROGRAM. Technical Report, Feb 1975 - Jan 1976**

Henry J. Kelley and Leon Lefton. Feb 1976. 58 p. refs. (Contract NAS2-8738) (NASA-CR-137819 Rept-75-27) Avail NTIS HC \$4.50 CSCL 01C

The numerical analysis of composite differential-turn trajectory pairs was studied for fast-evader and neutral-evader attitude dynamics idealization for attack aircraft. Transversality and generalized corner conditions are examined and the joining of trajectory segments discussed. A criterion is given for the screening of tandem-motion trajectory segments. Main focus is upon the computation of barrier surfaces. Fortunately from a computational viewpoint the trajectory pairs defining these surfaces need not be calculated completely; the final subarc of multiple-subarc pairs not being required. Some calculations for pairs of example aircraft are presented. A computer program used to perform the calculations is included. Author

**N76-21189\*#** Boeing Commercial Airplane Co. Seattle Wash  
**PHASE 2 PROGRAM ON GROUND TEST OF REFANNED JT8D TURBOFAN ENGINES AND NACELLES FOR THE 727 AIRPLANE VOLUME 3 GROUND TESTS Final Report**  
Dec 1975. 350 p. refs.  
(Contract NAS3-17842)  
(NASA-CR-134799 D6-42440-3-Vol-3) Avail NTIS  
HC \$10.00 CSCL 01C

The NASA Refan Program included full-scale performance and noise ground tests of both a current production (JT8D-15) and a refanned (JT8D-115) engine. A description of the two ground tests including detailed propulsion, noise, and structural test results is presented. The primary objectives of the total test program were comparison of JT8D-15 and JT8D-115 overall propulsion system performance and noise characteristics and determination of incremental component noise levels. Other objectives of the test program included: (1) determination of acoustic treatment effectiveness; (2) measurement of internal sound pressure levels; (3) measurement of inlet and exhaust hardware performance; (4) determination of center-engine surge margin; and (5) evaluation of certain structural characteristics associated with the 727 refan center-engine inlet duct and JT8D refan engine exhaust system. The JT8D-15 and -115 tests were conducted during September 1974 and January to March 1975, respectively. Analyses of the test data indicated that the JT8D-115, as compared to the JT8D-15, demonstrates a 12.5 percent to 13.2 percent reduction in static specific fuel consumption and a reduction of 6 to 7 PNdB in a weighted average value of static tone corrected perceived noise level. Separated into noise components, a significant reduction was shown for the inlet fan, aft fan exhaust duct flow turbine, and jet noises. However, core noise was increased. Photographs of test stands and test equipment are shown. Author

**N76-21190\*#** Boeing Commercial Airplane Co. Seattle Wash  
**PHASE 2 PROGRAM ON GROUND TEST OF REFANNED JT8D TURBOFAN ENGINES AND NACELLES FOR THE 727 AIRPLANE VOLUME 4 AIRPLANE EVALUATION AND ANALYSIS Final Report**

Dec 1975. 323 p. refs.  
(Contract NAS3-17842)  
(NASA-CR-134800 D6-42440-4-Vol-4) Avail NTIS  
HC \$9.75 CSCL 01C

The retrofit of JT8D-109 (refan) engines are evaluated on a 727-200 airplane in terms of airworthiness performance and noise. Design of certifiable hardware, manufacture, and ground testing of the essential nacelle components is included along with analysis of the certifiable airplane design to ensure airworthiness compliance and to predict the in-flight performance and noise characteristics of the modified airplane. The analyses confirm that the 727 refan airplane is certifiable. The refan airplane range would be 15% less than that of the baseline airplane and block fuel would be increased by 1.5% to 3%. However, with this particular 727-200 model with a brake release gross weight of 172,500 lb (78,245 kg), it is possible to operate the airplane (with minor structural modifications) at higher gross weights and increase the range up to 15% over the 727-200 (baseline) airplane. The refan airplane FAR Part 36 noise levels would be 6 to 8 EPNdB (effective perceived noise in decibels) below the baseline. Noise footprint studies showed that approach noise contour areas are small compared to takeoff areas. The 727 refan realizes a 68% to 83% reduction in annoyance-weighted area when compared to the 727-200 over a range of gross weights and operational procedures. Author

**N76-21191#** National Aviation Facilities Experimental Center Atlantic City, NJ

**RESPONSES OF SMALL RIGID AIRCRAFT TO DISCRETE AND CONTINUOUS GUST ANALYSIS, PHASE 1 Final Report, Nov 1972 - Nov 1974**

John Petrakis and Nelson Miller. Dec 1975. 121 p. refs.  
(AD-A020103/8 FAA-RD-74-160 FAA-NA-74-44) Avail  
NTIS HC \$5.50 CSCL 01/1

An evaluation is made of methods developed for estimating longitudinal and lateral rigid-body responses of airplanes to random atmospheric turbulence. A computer program, evolved from this study, calculates general aviation aircraft stability derivatives from known geometric properties used as inputs for the calculation of aircraft response (also a developed part of the computer program). It was found that the two degrees-of-freedom rigid-body power spectral density analysis produced lower normal load factor responses than a similar single degree-of-freedom analysis for aircraft of gross weight from 3,000 to 17,500 pounds. Also to

produce an equivalent discrete load factor for the two degrees-of-freedom analysis, a higher spectral velocity value must be used compared to that of the single degree-of-freedom approach  
Author

**N76-21193#** AMC Inventory Research Office Philadelphia Pa  
**DEMAND FORECASTING WITH PROGRAM FACTORS** Final Report

Martin Cohen Sep 1975 74 p refs  
(AD-A017858 IRO-182) Avail NTIS CSCL 15/5

Empirical demand forecasting studies have raised doubt about the often-made assumption that repair part demand is proportional to end-item usage. The study was made to test this assumption using a data base consisting of demands on the Army Aviation Systems Command National Inventory Point (AVSCOM NIPC) for thousands of stocked items. A simulation of the NIPC supply function was used to test the assumption and various proposed forecasting algorithms. The criterion was least holding and ordering cost for constant time-weighted requisitions short. The assumption that demand is proportional to end-item program was supported at least for the items responsible for the largest part of the costs and an improved algorithm was found. GRA

**N76-21194#** General Dynamics/Convair, San Diego, Calif  
**WEAPON SYSTEM COSTING METHODOLOGY FOR AIRCRAFT AIRFRAMES AND BASIC STRUCTURES VOLUME 1 TECHNICAL VOLUME** Final Report, Jul 1972 - Mar 1975

R E Kenyon Jun 1975 343 p refs  
(Contract F33615-72-C-2083 AF Proj 1368)  
(AD-A016408 AFFDL-TR-75-44-Vol-1) Avail NTIS CSCL 01/3

This volume provides a detailed description of the function and use of two weapon system costing methodologies for aircraft airframes and basic structures developed for the Air Force Flight Dynamics Laboratory for use in conceptual and preliminary design phases of weapon system development. The methods are a trade study costing method for detailed cost analysis of trade-offs between weight, cost type of construction and type of material and a system costing method for determining the projected cost of a complete airframe within the context of a weapon system development. This volume provides a technical discussion of method development. Trade-off capability has been provided for a range of alternative structure and material combinations. A technique for independently assessing complexity factors has been developed and demonstrated. Manufacturing costs are separately estimated for the primary elements of substructure: ribs, spars, covers, leading edges, trailing edges, tips, etc. The trade study method provides an iterative capability stemming from a direct interface with design synthesis programs. A detailed cost data base and system for data expansion is provided. The methods are designed for ease in changing cost estimating relationships and estimating coefficients resulting from cost data update.  
Author (GRA)

**N76-21195#** General Dynamics/Convair, San Diego, Calif  
**WEAPON SYSTEM COSTING METHODOLOGY FOR AIRCRAFT AIRFRAMES AND BASIC STRUCTURES VOLUME 2 ESTIMATING HANDBOOK AND USER'S MANUAL, PART 2** Final Report, Jul 1972 - Feb 1975

R E Kenyon May 1975 371 p refs  
(Contract F33615-72-C-2083 AF Proj 1368)  
(AD-A016410 AFFDL-TR-75-44-Vol-2-Pt-2) Avail NTIS CSCL 01/3

For abstract see N76-21194

**N76-21196#** Air Force Systems Command Wright-Patterson AFB Ohio Foreign Technology Div  
**ANALYSIS OF FAILURES IN THE PARTS OF AN AIRCRAFT UNDERCARRIAGE**

Z S Kulyshcheva and A G Yamov 12 Nov 1975 11 p refs  
Transl into ENGLISH from Tr Rizhskii Inst Inzh Gradzhanskoi Aviatsii (USSR) no 202 p 54-59  
(AD-A017928 FTD-ID(RS)-2308-75) Avail NTIS CSCL 01/3

Variable loads of aircraft undercarriages are discussed. Loads from nonquality landing, the nature of the motion of the aircraft, the degree of unevenness of the airfield, and the rigidity of shock absorption are considered. Fatigue cracks and bolted joints are the most frequently caused defects.  
JMS

**N76-21205\*#** Pratt and Whitney Aircraft East Hartford Conn  
**MODELING AND ANALYSIS OF THE TF30-P-3 COMPRESSOR SYSTEM WITH INLET PRESSURE DISTORTION**  
R S Mazzawy and G A Banks Apr 1976 133 p refs  
(Contract NAS3-18535)  
(NASA-CR-134996 PWA-5302) Avail NTIS HC \$6.00 CSCL 21E

Circumferential inlet distortion testing of a TF30-P-3 afterburning turbofan engine was conducted at NASA-Lewis Research Center. Pratt and Whitney Aircraft analyzed the data using its multiple segment parallel compressor model and classical compressor theory. Distortion attenuation analysis resulted in a detailed flow field calculation with good agreement between multiple segment model predictions and the test data. Sensitivity of the engine stall line to circumferential inlet distortion was calculated on the basis of parallel compressor theory to be more severe than indicated by the data. However, the calculated stall site location was in agreement with high response instrumentation measurements.  
Author

**N76-21206\*#** National Aeronautics and Space Administration  
Lewis Research Center Cleveland Ohio

**NOISE REDUCTION FROM THE REDESIGN OF A FAN STAGE TO MINIMIZE STATOR LIFT FLUCTUATIONS**

James H Dittmar and Richard P Woodward 1976 10 p refs  
Proposed for presentation at 3d Aero-Acoustics Conf Palo Alto Calif 20-23 Jul 1976 sponsored by AIAA  
(NASA-TM-X-71896 E-8682) Avail NTIS HC \$3.50 CSCL 20A

An existing fan stage redesigned to reduce stator lift fluctuations was acoustically tested for reduced noise generation. The lift fluctuations on the stator were reduced by increasing the stator chord, adjusting incidence angles and by adjusting the rotor velocity diagrams. The experiments showed significantly reduced broadband noise levels in the middle to high frequencies. Blade passage tone power was not reduced but decreases in the harmonics were observed. Aerodynamic improvements in both performance and efficiency were obtained.  
Author

**N76-21208\*#** National Aeronautics and Space Administration  
Lewis Research Center Cleveland Ohio

**STIMULATION OF A TURBOFAN ENGINE FOR EVALUATION OF MULTIVARIABLE OPTIMAL CONTROL CONCEPTS**

Kurt Seldner 1976 12 p refs. Prepared for Presentation at Joint Autom Control Conf Lafayette Ind 27-30 Jul 1976 sponsored by the Am Autom Control Council  
(NASA-TM-X-71912 E-8703) Avail NTIS HC \$3.50 CSCL 21E

The development of control systems for jet engines requires a real-time computer simulation. The simulation provides an effective tool for evaluating control concepts and problem areas prior to actual engine testing. The development and use of a real-time simulation of the Pratt and Whitney F100-PW100 turbofan engine is described. The simulation was used in a multi-variable optimal controls research program using linear quadratic regulator theory. The simulation is used to generate linear engine models at selected operating points and evaluate the control algorithm. To reduce the complexity of the design, it is desirable to reduce the order of the linear model. A technique to reduce the order of the model is discussed. Selected results between high and low order models are compared. The LQR control algorithms can be programmed on digital computer. This computer will control the engine simulation over the desired flight envelope.  
Author

**N76-21209\*#** National Aeronautics and Space Administration  
Langley Research Center Langley Station Va  
**HYPERSONIC RESEARCH ENGINE/AEROTHERMODYNAMIC INTEGRATION MODEL, EXPERIMENTAL**

**RESULTS VOLUME 4 MACH 5 COMPONENT INTEGRATION AND PERFORMANCE**

Earl H Andrews Jr and Ernest A Mackley Apr 1976 526 p refs Prepared in cooperation with AirResearch Mfg Co) 3 Vol (Contract NAS1-6666)

(NASA-TM-X-72824) Avail NTIS HC \$13 00 CSCL 21E

Tabulated computer program results of wind tunnel tests for Mach 5 components are presented Author

**N76-21210\*# Pratt and Whitney Aircraft East Hartford Conn COUPLING OF HELMHOLTZ RESONATORS TO IMPROVE ACOUSTIC LINERS FOR TURBOFAN ENGINES AT LOW FREQUENCY**

L W Dean Aug 1975 66 p refs

(Contract NAS3-18552)

(NASA-CR-134912 PWA-5311) Avail NTIS HC \$4 50 CSCL 21E

An analytical and test program was conducted to evaluate means for increasing the effectiveness of low frequency sound absorbing liners for aircraft turbine engines Three schemes for coupling low frequency absorber elements were considered These schemes were analytically modeled and their impedance was predicted over a frequency range of 50 to 1 000 Hz An optimum and two off-optimum designs of the most promising a parallel coupled scheme were fabricated and tested in a flow duct facility Impedance measurements were in good agreement with predicted values and validated the procedure used to transform modeled parameters to hardware designs Measurements of attenuation for panels of coupled resonators were consistent with predictions based on measured impedance All coupled resonator panels tested showed an increase in peak attenuation of about 50% and an increase in attenuation bandwidth of one one-third octave band over that measured for an uncoupled panel These attenuation characteristics equate to about 35% greater reduction in source perceived noise level (PNL) relative to the uncoupled panel or a reduction in treatment length of about 24% for constant PNL reduction The increased effectiveness of the coupled resonator concept for attenuation of low frequency broad spectrum noise is demonstrated Author

**N76-21211# McDonnell-Douglas Corp Long Beach Calif AIRCRAFT NOISE DEFINITION PHASE 2 ANALYSIS OF FLYOVER-NOISE DATA FOR DC-8-61 AIRCRAFT Final Report, Nov 1973 - Aug 1974**

R E DeLapp Aug 1974 177 p refs

(Contract DOT-FA73WA-3161)

(AD-A019759/0 MDC-J4443 FAA-EQ-74-5) Avail NTIS HC \$6 75 CSCL 20/1

Phase II of the Aircraft Noise Definition program consisted of a DC-8-61 flight test program with an objective to improve the statistical accuracy of the noise data reported in Phase I of the program and to broaden the data base to include measurements at long distances and at a thrust required for a steep approach Noise measurements were made during flyovers up to an altitude of 8 000 feet at sideline distances up to 8 000 feet and at target thrusts of 15 000 10 000 5 000 3 200 and 2000 pounds This document reports the data acquisitions, the analysis procedure and the results in terms of variations in reference-day EPNL and A-weighted sound level with slant range overhead to sideline noise level relationship and data showing lateral noise attenuations Data accuracy is described in terms of assignable confidence limits A comparison was made between reference-day noise levels determined for surface weather conditions and by a method that accounts for upper-air variations in the sound-path weather A method that adjusts for lateral noise attenuation in computing EPNLs for sideline locations was suggested Photographs and descriptions of airborne computers and ground equipment employed (mobile sound recording equipment) are included Author

**N76-21216\*# National Aeronautics and Space Administration Langley Research Center Langley Station Va**

**A SIMULATION STUDY OF CURVED, DESCENDING, DECELERATING, LANDING APPROACHES FOR TRANSPORT AIRCRAFT**

James E Dieudonne Randall D Grove and George G Steinmetz Washington Apr 1976 43 p refs

(NASA-TN-D-8190 L-10584) Avail NTIS HC \$4 00 CSCL 01C

A system which is capable of controlling an aircraft automatically along a curved descending decelerating approach was described A simulation study was conducted to determine the necessary modifications to the basic flight-proven control system This basic system is presently being used to accomplish straight-in automatic landing approaches on a short-haul transport aircraft (B-737 terminal configured vehicle) This study shows that both 3 deg (normal) and 5 deg (steep) approaches could be accomplished with only minor modifications to the basic control system Author

**N76-21601# Laboratorium fuer Betriebsfestigkeit Darmstadt (West Germany)**

**REVIEW OF INVESTIGATIONS ON AERONAUTICAL FATIGUE IN THE FEDERAL REPUBLIC OF GERMANY, JULY 1973 - APRIL 1975**

O Buxbaum Apr 1975 169 p refs Presented at the 14th Conf of the Intern Comm on Aeron Fatigue Lausanne Switz, 1975

(LBF-S-119) Avail NTIS HC \$6 75

Work carried out in the field of fatigue of aircraft structures is reviewed Topics covered include the measurement and analysis of operational loads fatigue tests under random or randomized sequences the fatigue behavior of notched specimens and joints, cyclic stress-strain behavior and low cycles fatigue crack propagation fracture mechanics, and residual static strength

ESA

**N76-21990\*# National Aeronautics and Space Administration Langley Research Center Langley Station Va**

**SOURCES AND CHARACTERISTICS OF INTERIOR NOISE IN GENERAL AVIATION AIRCRAFT**

John J Cathelines and Sunil K Jha (Cranfield Inst of Technol England) Apr 1976 24 p refs Presented at 91st Meeting Acoust Soc Am Washington D C 5-9 Apr 1976

(NASA-TM-X-72839) Avail NTIS HC \$3 50 CSCL 20A

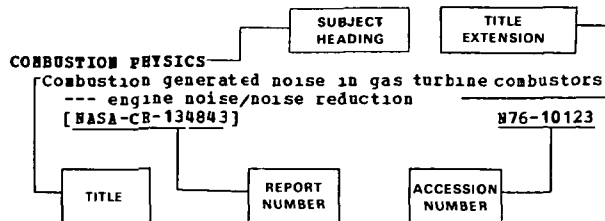
A field study was conducted to examine the interior noise characteristics of a general aviation aircraft The goals were to identify the major noise sources and their relative contribution and to establish the noise transmission paths and their relative importance Tests were performed on an aircraft operating under stationary conditions on the ground Results show that the interior noise level of light aircraft is dominated by broadband low frequencies (below 1 000 Hz) Both the propeller and the engine are dominant sources however the contribution from the propeller is significantly more than the engine at its fundamental blade passage frequency The data suggest that the airborne path is more dominant than the structure-borne path in the transmission of broadband low frequency noise which apparently results from the exhaust Author

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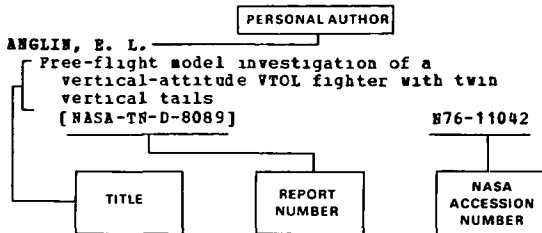
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